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55TH CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { DOCUMENT No. 95.

REPORT

OF THE

ARMOR FACTORY BOARD,

WITH

ACCOMPANYING DOCUMENTS.

DECEMBER 7, 1897.—Referred to the Committee on Naval Affairs and ordered to be printed.

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REPORT.

NAVY DEPARTMENT,
Washington, December 6, 1897.

SIR: I have the honor to forward herewith, for the information and consideration of Congress, the report of the Armor Factory Board, appointed under authority of the act approved July 19, 1897, making appropriations to supply deficiencies in the appropriations for the fiscal year ending June 30, 1897, and for other purposes, which provides as follows:

In case the Secretary of the Navy shall find it impossible to make contracts for said armor within the limits as to price above fixed, he shall be, and hereby is, authorized and directed to take steps to establish a Government armor factory of sufficient capacity to make such armor. In executing this authority he shall prepare a description and plans and specifications of the land, buildings, and machinery suitable for the factory; and shall advertise for proposals to furnish such land, buildings, and machinery as a whole plant, or separately, for the land or buildings or the whole or any part of said machinery, and report to Congress at its next session. The Secretary shall also appoint an armor factory board, to consist of competent naval officers of suitable rank, to advise and assist him in executing the authority hereby conferred.

This report, with its appendixes, is transmitted to Congress in order that it may be advised at the earliest moment of all the information obtained by the board, and of its conclusions.

In further compliance with this act, the Department has issued advertisements "for proposals to furnish such lands, buildings, machinery," etc., and bids will be opened on the 29th of January next, the result of which will be thereupon transmitted to Congress.

I have the honor to be, very respectfully,

JOHN D. LONG, *Secretary.*

The SPEAKER OF THE HOUSE.

NAVY DEPARTMENT,
Washington, December 1, 1897.

Hon. JOHN D. LONG,
Secretary of the Navy.

SIR: I have the honor herewith to transmit the report of the Armor Factory Board appointed by you in pursuance of the authority contained in the act of Congress approved July 19, 1897.

Very respectfully,

J. A. HOWELL,
Commodore, U. S. Navy, President Armor Factory Board.

NAVY DEPARTMENT,
Washington, December 1, 1897.

Hon. JOHN D. LONG,
Secretary of the Navy.

SIR: The Armor Factory Board met at this place at 10 a. m. on the 9th day of August, 1897, in compliance with the following order:

4197-97.] NAVY DEPARTMENT,
Washington, August 5, 1897.

SIR: In pursuance of the authority contained in the act entitled "An act making appropriations to supply deficiencies in the appropriations for the fiscal year ending June 30, 1897, and for prior years, and for other purposes," approved July 19, 1897, under the heading "Armor plate," the Department having found it impossible to make contracts for the armor for battleships Nos. 7, 8, and 9 within the limits as to price fixed in said act, and with a view to preparation for the establishment of a Government armor factory of sufficient capacity to make such armor, a board consisting of yourself as president, and of Capt. Alexander H. McCormick, Civil Engineer Mordecai T. Endicott, Chief Engineer James H. Perry, and Lieut. Frank F. Fletcher, United States Navy, as members, and Lieut. Washington I. Chambers, United States Navy, as recorder, is hereby appointed for the purpose of advising and assisting the Department in executing the authority conferred upon it by said act, and will assemble at the Navy Department, Bureau of Ordnance, at 10 o'clock a. m. on Monday next, the 9th instant.

It being required by the act above mentioned that the Department shall report to Congress at its next session upon the subject herein referred to, the Board will proceed as expeditiously as may be in the performance of the duties hereby devolved upon it, employing a competent stenographer and typewriter at the current market rates for such services, in accordance with an agreement in writing beforehand between the president of the board and the person employed. The board may apply to the Department for the assistance of such draftsmen as may prove to be necessary, and for authority to employ experts whose services may be required. Such travel as may be necessary on the part of the members of the board and of persons employed as above authorized will be performed upon written orders of the president of the board or the senior member present, the same to be submitted to the Department for its subsequent approval.

It is expected that the board will exercise its discretion and judgment with due regard to the act of Congress above mentioned in treating this subject, but it is desired that the board will ascertain by full and thorough investigation and research and report comprehensively to the Department as to—

What steps are necessary to establish a Government armor factory of sufficient capacity to meet the probable requirements of said act of Congress, submitting a description and plans and specifications of the land, buildings, and machinery suitable and necessary for such a factory in accordance with the board's conclusions; and whether,

In a Government factory, the manufacture of the armor only should be carried on—that is, by procuring the ingots by purchase, or whether the factory should include a plant for producing the steel necessary for use in making the armor, including a statement of the advantages or disadvantages or necessities of the case as ascertained by the board, together with estimates of the cost of an armor factory with a steel plant included and of one without such a plant.

The requirements of a thoroughly modern first-class establishment should be scheduled and enumerated as much in detail as may be necessary to enable the Department to form a clear and concise estimate of the scheme submitted and of its extent, showing the probable cost of integral parts.

The board will also, at as early a date as practicable, frame and submit to the Department a form of advertisement for proposals to furnish a plant as a whole, or any part or parts thereof separately, as provided by the aforesaid act of Congress.

Very respectfully,

THEODORE ROOSEVELT, *Acting Secretary.*

Commodore JOHN A. HOWELL, U. S. N.,
Commandant Navy-Yard, League Island, Pa.

The board has continued in session at intervals until this date, and, after as full and thorough an investigation and research as the time at its disposal has permitted, respectfully submits the following report:

In considering the steps "necessary to establish a Government armor factory of sufficient capacity to meet the probable requirements

of said act of Congress," the board, after consultation with the Acting Secretary of the Navy, concluded that the basis of this capacity should be a plant capable of producing sufficient nickel steel, face-hardened, reforged armor for two battle ships, or about 6,000 tons of armor per year; the requirements being those "of a thoroughly modern, first-class establishment," as necessitated by the order.

In order to ascertain the capacities and facilities of existing plants capable of producing armor, visits were made to the works of the Bethlehem Iron Company, South Bethlehem, Pa.; the Carnegie Steel Company, Munhall, Pa.; and the Illinois Steel Company, South Chicago, Ill. The board was courteously received and permitted to inspect the works at each of these places. Photographs of those portions of the works adapted for making armor are appended. (See Appendix G.)

In preparing plans (see Appendix A) the board was fortunate in securing the services of the eminent engineer and steel expert, Mr. John Fritz, who, being under no obligations to any armor-making firm while employed by the board, had been actively engaged in the establishment of armor plants and in the making of armor. The services of an expert were essential, and under the direction of the board Mr. Fritz, employing his own draftsmen, has enabled the board to present more complete details than would have been possible without him in the limited time allowed.

In all respects the report now submitted is as complete as the time at the disposal of the board has permitted.

In reporting what steps are necessary to establish a Government armor factory of sufficient capacity to meet the probable requirements of the act of Congress approved July 19, 1897, we respectfully submit the following considerations:

1. The plans, estimates, and specifications included in this report are sufficiently in detail to enable the Department to understand the nature, extent, and cost of such an undertaking, and to enable Congress to make the necessary appropriation for beginning the work.

2. The proposals to be received in answer to the advertisement contemplated by the Department will doubtless contain propositions from some suitable place or places where the community, desirous of securing the prestige and benefits of such an industrial establishment, will make advantageous offers concerning the land and other facilities.

3. After considering the various propositions received, the Department can select the most advantageous site and then furnish a final plan of the arrangement of the buildings, in which due consideration should be given to the local conditions of foundation, drainage, water supply, railroad connections, prevailing winds, etc. The general arrangement shown on plan O, Appendix A, should be adhered to as closely as permitted by the local conditions of the site selected.

4. To arrange all the contracts satisfactorily, more complete specifications than herein submitted may be needed for some of the parts, but it is believed that the work may be vigorously pushed to completion within two years from the time that it is appropriated for by Congress.

In preparing the accompanying plans (see Appendix A), the board has departed somewhat from the arrangement of the plants existing at South Bethlehem, Pa., and Munhall, Pa., and has taken advantage of its inspection of those plants not only to embody all the features essential to such an establishment, but to introduce certain modifications and improvements in the arrangement and the selection of tools. These plans are the result of a systematic study and an endeavor to devise an deal plant for the purpose intended.

After deciding upon the yearly output or capacity of the plant, the character, size, and number of the best tools necessary to perform the given work and their most convenient arrangement was determined. Many of the tools selected are of special design and are not contained in the trade catalogues, but they can be obtained from reliable manufacturers who have enabled the board to determine their actual cost by submitting estimates for the work.

After deciding upon the best arrangement of tools, the buildings were designed to cover them and the principal features governing the design of each building were (1) substantial foundations, (2) structures strong, fireproof, and economical, neat but not extravagant, (3) carefully considered lighting, heating, and ventilating arrangements, (4) roof trusses light and economical, but strong enough to withstand any load they may be required to bear, and (5) all parts of each shop to be reached by overhead cranes. To embody these features the buildings are designed to be self-contained steel structures independent of the brick walls which are to fill in the spaces between columns, but not to sustain any of the load.

The estimated cost is based mainly upon the figures obtained from responsible contractors in the various branches of the work required.

As a preliminary step in the description of this plant we briefly describe as follows:

THE PROCESS OF MANUFACTURE.

This process does not include the production of the iron from the ore with the blast furnaces necessary for that work. The process of manufacture of armor plate herein contemplated begins with the production of steel in basic open-hearth furnaces, the pig iron, and other materials necessary to such a beginning being purchased as may be most advantageous from the mercantile establishments of the country.

1. The open-hearth furnaces having been suitably prepared and heated by gas producers, and the requisite proportions of pig iron, scrap, and ore having been assembled according to their analyses, the charging boxes, each filled with certain weights and classes of the charge in the open-hearth storehouse, are brought on narrow cars before the doors of the furnaces, and their contents are then successively emptied into the furnaces by an electric charging machine controlled by one man. The dolomite and "finals" are added by hand at the proper time under the direction of a skilled melter. In the meantime the mold has been prepared and heated in the casting pit and the ladles have been heated by oil burners. When the charge is ready to pour, each of the required furnaces is tilted over and its contents poured into a ladle. The ladles are then transported on ladle cars to exact positions over the mold feeders and the melted steel is run into the mold from the bottom of each ladle. The ingot, when solidified in the mold, will have an excess of metal, known as the "sink head" or "riser," so shaped that it may fit the chuck of a porter bar for use in handling under the forge press. The capacity of this department is sufficient to run an ingot of 130 tons.

The ingot is lifted from the mold by an overhead crane, and having been placed on a heavy car, is then transported to a suitable place, where any fissures or foreign substances shown on its surface are chipped out.

The building in which the ingot is cast is designated the open-hearth department, and has been designed in these plans to be capable of

extension to provide a rolling mill for the lighter armor plates under the same roof. (Appendix A, Nos. 0, 1, 2, and 3.)

2. The ingot is then transported to the forge shop, is grasped by a porter bar, and placed into a heating furnace, which has previously been prepared and heated for this purpose. After being heated to the desired temperature, and the forge press is ready for operation, the ingot is withdrawn from the furnace by the porter bar, which is itself manipulated by an overhead crane. After the scale has been loosened and removed from the surfaces of the ingot, it is placed on the anvil of the hydraulic forge press and forged down. A large portion of excess metal is then cut off and a smaller projection is forged at one end for subsequent handling by a porter bar. Sometimes more than one heating is necessary to complete this process. The surface of the ingot is then again cleared of scale and, if necessary, it is chipped.

The ingot is then transported to a cementing furnace which has been suitably prepared with a bed of carburizing material, and, after having been placed with its face on this bed and its back covered with sand, brick, or other refractory material, the furnace is gradually heated to a temperature of about 2,200° F. The operation of cementation lasts from eighteen to thirty days, after which the ingot is again scaled and chipped, and, after reheating near the forge press, it is reforged down to final thickness. Occasionally a plate requires recementing before reforging. The building in which the operations of forging and cementing are performed is designated the forging and cementing shop. (Appendix A, Nos. 4, 5, 6, 7, and 8.)

4. The ingot or plate is now transported to another shop, designated the machine shop, where it is machined to approximate dimensions. (Appendix A, Nos. 16 and 17.)

5. The plate is then transported to the bending shop, where it is reheated in an appropriate furnace and then bent to shape under the hydraulic bending press. This operation often requires several reheatings.

6. After bending, the plate is transported to another heating furnace and there heated to the proper temperature for tempering; it is then withdrawn and placed upon a tempering table, where it is sprayed with jets of ice-cold water by a suitable spraying machine. If in the tempering process the plate has warped too much out of shape, it is again reheated, rebent, and retempered. After tempering, it is sometimes placed in an oil bath to complete its cooling slowly. The building in which these operations are performed is designated the bending and tempering shop. (Appendix A, Nos. 13, 14, and 15.)

7. The plate is then again transported to the machine shop to be planed and ground to finished dimensions and to have its bolt holes drilled and tapped and to have portholes finally shaped, when needed.

8. From the machine shop it is transported to a building designated the erecting shop for assembling and final fitting. (Appendix Nos. 19 and 20.)

In addition to the shops above mentioned, other accessories are provided for, such as:

(*a*) A boiler house. (Appendix A, Nos. 9 and 10.)

(*b*) A power house for supplying electrical power and lighting to various parts of the plant. (Appendix A, No. 11.)

(*c*) A blacksmith shop for the forging of armor bolts and other small parts. (Appendix A, No. 21.)

(*d*) A carpenter shop. (Appendix A, No. 23.)

(*e*) An office building equipped with a drafting department. (Appendix A, No. 24.)

(*f*) A chemical and physical laboratory. (Appendix A, No. 25.)

(*g*) A locomotive house. (Appendix A, No. 22.)

(*h*) A suitable space arranged for stowage of raw materials—pig iron, scrap, nickel ore, coal, dolomite, coke, etc.

OPEN-HEARTH DEPARTMENT.

[Drawings 1, 2, 3, 12, 30, 31, and 34, Appendix A.]

The building will be of the form and construction shown on the plans submitted herewith.

There will be two craneways, one in front of the furnaces and over the charging gallery, and the other in the rear of the furnaces and over the casting pit and railroad track.

Ample drainage will be provided.

A full water supply will be provided and distributed at such points as may be required.

The building will be lighted with arc lights.

A standard-gauge railroad track will lead along inside of the building beyond the casting pit.

At some convenient point outside the building there will be a track scales capable of weighing 150 tons.

There will be four Wellman tilting, open-hearth, basic furnaces, with regenerator and gas producers arranged as shown on the plans, and operated by hydraulic power. Two of these furnaces will have a capacity of 40 tons each, one of them a capacity of 30 tons, and one a capacity of 20 tons. These furnaces are to be so fitted that either oil or producer gas may be used as fuel. Each furnace is to have a separate smoke pipe.

The regenerators are to be located under the gallery and clear of the furnaces, so that no part of the weight of the latter will come on them.

The producers are to be located outside of the main building and directly opposite the furnaces.

There will also be a heating furnace, with regenerators, arranged as shown, with hearth 8 by 12 feet.

Along the fronts of the furnaces there will be a charging gallery with tracks, upon which the cars carrying the charging boxes and the charging machine will run. The car tracks will lead down from the gallery by an incline, and will be continued along in front of the metal magazines or storehouses. The boxes are to be here handled by a 5-ton electric crane fitted to discharge from a standard-gauge car into the magazine, and from the magazine on the cars conveying the charging boxes.

On the craneway over the fronts of the furnaces there will be a 20-ton electric crane with sufficient travel of bridge and trolley to command the furnace fronts, the tops of the air and gas inlets to the furnaces, and the charging machine. The speed of travel of the crane will be 250 feet per minute, of the trolley 100 feet, and of the hoist 20 feet.

On the craneway in the rear of the furnaces there will be three electric cranes to command the ladles, the casting pit, and the railroad track. One of these cranes is to be of 160 tons capacity and to have a speed of travel of 150 feet per minute, speed of trolley 100 feet, and of hoist 8 feet. The other two cranes are to be of 75 and 50 tons capacity, respectively, and to have a speed of travel of 150 feet per minute, of trolley 100 feet, and hoist 10 feet. All the operations of all

the cranes are to be by electricity, and the hoisting gear is to be so arranged that the hoist will be vertical through its entire range.

The charging machine is to be driven by electricity, and is to have sufficient power to pick up a box from the car, project it into the furnace, revolve the box and empty its contents, and then return the box to the car. The machine is to be self-propelling, and to have all operating gear so arranged that one man can easily control all its motions without changing his position.

There will be two cupolas for melting cast iron; one will be 6 feet internal diameter and the other 3 feet, and they will be fitted with the necessary blowers, elevators, ladles, and other foundry appliances.

There will be two core ovens, one 7 by 12 feet and the other 12 by 24 feet internal dimensions.

There will be a casting pit extending in front of and beyond the furnaces; this pit will be 20 feet wide and 20 feet deep for 36 feet of its length, and 17 feet wide and 20 feet deep for the remainder. The sides will be of masonry. Over the pit will be a track for the trucks and cars carrying the ladles.

There will be two ladles furnished for each melting furnace; these ladles must be strongly and substantially made, and each one of sufficient size to contain the entire contents of the furnace for which it is intended. The ladles will be tapped from the bottom, and they will be fitted with truck wheels, so they can be run from the furnace spout to the top of the pit truck and be thence transported to any part of the casting pit. The ladles will also have lugs secured to them, so that, if desired, they can be transported by the traveling cranes.

There will be four pit trucks or cars arranged to travel on the track over the casting pit; the upper sides of these trucks will have tracks fitted to receive the ladles as they come from the furnaces.

The pumps for supplying the hydraulic power for operating the furnaces must be outside packed, single acting, duplex-plunger pumps. The water valves must be readily accessible, and the steam valves must be adjustable from outside the chests. Steam for these pumps will be supplied by a pipe led into the building from the boiler house.

A full supply of flasks for ingots of various shapes and sizes will be furnished.

A full supply of ladles and other foundry appliances will be furnished.

FORGING AND CEMENTING SHOP.

[Drawings 4, 5, 6, 7, 8, 18, 27, 28, 29, and 33, Appendix A.]

The building for this department will be of the dimensions and construction shown on the plans submitted herewith.

A craneway will be built on top of the columns in the main part of the building; this craneway will extend from each end of the building up to the forging press. On the craneway over the furnaces will be one 100 ton electric crane with a speed of travel of 150 feet per minute, speed of trolley 100 feet, and of hoist 8 feet. On the craneway in the opposite end of the building will be one 50-ton electric crane with speed of travel of 250 feet, speed of trolley 100 feet and of hoist 10 feet per minute. The construction of the craneway will be as shown.

The building will have a complete system of drainage.

The building will be thoroughly lighted by arc lights.

There will be a standard-gauge railroad track leading through the building, passing along the center in front of the furnaces and along one side by the press.

There will be one hydraulic forging press, fitted with at least two pressure cylinders, capable of exerting a maximum pressure of 14,000 gross tons; the vertical rise of the ram will be 10 feet and the distance between the housings or columns 14 feet. The press will also be fitted with two side rams, each capable of exerting a pressure of 4,000 tons, and having a horizontal movement of ram of 4 feet.

The pumps for this press will be driven by a vertical, simple, three-cylinder crank and fly-wheel engine placed beyond and on one side of the press, as shown on the plan. The pumps will be worked directly from the engine by rock shafts, or links, or both.

The gear for operating the press will be placed directly opposite to it, on the side farthest from the engine.

On each side of the press will be a small hydraulic cylinder, in which constant pressure will be maintained by means of a special accumulator; the rams of these cylinders will be connected with the ram of the press to return it to its highest position whenever the pressure is relieved from the forging cylinders.

On each front of the press will be a craneway extending entirely across the building to the ingot-heating furnaces on each side. On each of these craneways will be one 160-ton traveling crane fitted to raise, lower, revolve, and transport the ingots and porter bars. The span of each of these cranes will be about 47 feet; the raising and lowering will be by hydraulic power and all other motions by electricity. The speed of the cranes will be 150 feet per minute, of trolley 100 feet, and of hoist 10 feet; total amount of hoist to be 10 feet.

Hydraulic manipulators are to be fitted below the floor to move the anvil and dies back and forth as may be required.

There will be four regenerative furnaces for heating ingots, two on each side of the building and opposite to the press. The fuel will be producer gas or oil, and each pair of furnaces on the same side will be provided with a producer, placed opposite and outside the building. Each furnace will have a separate smoke pipe. Each furnace will be 16 by 16 by 9 feet 6 inches in height. The doors of the furnaces will be operated by hydraulic power.

There will be four regenerative furnaces, two on each side of shop, for heating plates for reforging. These furnaces will have movable or car bottoms, and are to use producer gas or oil. Each adjacent pair of furnaces will have a producer, placed opposite and outside the building. Each furnace will have a separate smoke pipe. The bottoms and doors of the furnaces are to be operated by hydraulic power. A track for the car bottom will extend under each furnace and to the center of the shop.

There will be sixteen regenerative cementing furnaces, eight on each side of the building. Each furnace will have a separate smoke pipe and each pair of adjacent furnaces will have a producer, placed opposite and outside of the building. The furnaces will have car bottoms. The fuel will be producer gas or oil. Eight of these furnaces will be 30 feet in length and eight 22 feet; all of them will be 14 feet in width. There will be a track running under each furnace and to the center of the building. The car bottoms and doors will be operated by hydraulic power.

The pumps, except those for the forging press, will be compound, outside packed, single-acting duplex-plunger pumps. They must be of such pattern that the water valves will be readily accessible and the steam valves adjustable from outside. Steam for these pumps will be led from the boiler house, and a separator will be placed in the pipe.

All the necessary accumulators for operating the furnace doors and bottoms, under constant pressure, will be provided; also a full assortment of porter bars, chucks, counterweights, and forging tools.

There will be one electrically driven emery grinder for cutting the scale from the edges of plates after cementation.

There will also be two trepanning tools for cutting test specimens.

BENDING AND TEMPERING SHOP.

[Drawings 13, 14, 15, 18, and 26, Appendix A.]

The building for the bending and tempering department will be of the size and construction shown on the plans submitted.

A standard-gauge railroad track will extend entirely through the building, passing on one side of the bending press; there will be switches and short lengths of track leading to each front of the press and under the press cranes.

On the craneway of the shop will be two 75-ton electric cranes, having a speed of 150 feet per minute, of trolley of 100 feet, and of hoist 10 feet. These craneways will extend the whole length of the building and the cranes will pass over the top of the bending press.

The building will be lighted by arc lights and will have full water supply distributed as may be necessary.

The bending press will be capable of exerting a maximum pressure of 7,500 gross tons. It will have two cylinders, and the distance between the housings and between the heads will be 13 feet; the stroke of ram will be about 8 feet. It will be operated by compound, single acting, outside packed, duplex plunger pumps, placed as near the press as they conveniently can be. The pumps must be so designed that the water valves are readily accessible, and the steam valves adjustable from outside the chest.

The ram is to be returned to its highest position—when pressure is relieved from it—by two small cylinders whose rams are attached to its ends and in which constant pressure is maintained by a special accumulator.

The anvil is to be moved by hydraulic manipulators.

The hand gear for manipulating the press is to be placed directly opposite it and on one side.

There will be a craneway extending from each front of the press, a distance of about 68 feet; they will be the width of the press, and on each of them will be a traveling crane of 75 gross tons capacity for raising, lowering, revolving, and transporting the plate to be bent. The raising and lowering will be by hydraulic power, all other manipulations by electricity. The speed of travel will be 150 feet per minute, of trolley 100 feet, and of hoist 10 feet. Amount of hoist, 8 feet.

There will be four regenerative heating furnaces, all on the same side of the building, and as near the press as they can be conveniently placed. They are to be 27 feet in length, 12 feet wide, and 12 feet in height. They are to have car bottoms and lifting doors at the ends, to be operated by hydraulic power. The fuel will be producer gas or oil, and the producers will be placed opposite and outside the building. Each furnace will have a separate smoke pipe.

A car track will extend from under each furnace to the center of the building, so the car bottom of each furnace can be run directly under the press cranes.

There will be three furnaces with removable tops and ends for heating plates for tempering. All of these furnaces will be 27 feet in

length and 12 feet in height; two will be 9 feet in width and the other 14 feet. They are to be fired along the sides, and the fuel will be wood or coal.

There will be a spraying apparatus by which a large number of jets of filtered ice-cold water may be driven against the cemented side of a plate, and water of normal temperature on the other side at the same time. The apparatus will consist of pumps, ice tank, supports for the plate, and the necessary perforated piping above and below the supports. The upper piping will be arranged with flexible joints, so that it can be swung in any direction.

There will also be an oil tank, about 30 feet in diameter and 15 feet deep, sunk below the floor, for oil tempering; there will be a tank of the same dimensions placed outside the building with facilities for cooling the oil.

There will be the necessary pumps and accumulators for operating the doors and car bottoms of the furnaces, the anvil of the press and the hoists of the press cranes. The pumps will be compound, single acting, outside packed, duplex plunger pumps, with water valves readily accessible and steam valves adjustable from the outside.

There will also be an annealing pit about 20 by 30 feet and 15 feet in depth.

A full supply of shop appliances and accessories, as anvils and blocks, porter bars, slings, etc., will be furnished.

MACHINE SHOP.

[Drawings 16, 17, and 33 Appendix A.]

This shop will be of the dimensions and construction shown on the plans submitted herewith.

On the craneways will be two 75-ton electric cranes, running the entire length of the shop; the speed of travel will be 250 feet per minute; of trolley 100 feet, and of hoist 10 feet; each crane to have a supplemental hoist of 15 tons, with a speed of 25 feet.

At one end of the shop a clear space about 100 feet will be kept; at the other end, beyond the large tools, will be placed a face plate 32 feet square.

The shop is to be lighted by arc lights and incandescent portables. It will be thoroughly heated by taking fresh air from the outside, passing it around a steam coil by a blower, and then distributing it through the building.

All the large tools are to be arranged on one side of the shop, leaving ample space on the other side for the passage of cars or armor plates suspended from the cranes.

A standard-gauge railroad track will extend entirely through the shop, running along the side opposite to the heavy tools.

Each large machine tool is to be driven by a separate, independent electric motor. Whenever possible the motor is to be attached directly to the machine; when this can not be done, as with a machine to be driven at many different speeds, the motor will be connected to a countershaft with speed cone.

There will be a separate motor driving a main shaft for all the power tools in the tool room, and another one, driving a shaft, for all the small tools in the wing, including the armor-bolt lathes.

There will be a fully equipped tool room located in one of the wings. It will contain two 16-inch screw-cutting lathes of the very latest design and having all improvements, such as hollow spindle, taper attachment,

adjustable bearings, etc., a milling machine, a shaper, a slotter, and a drill press. There will also be a work bench with vises, racks for the tools, lockers for stores, and a desk.

There will be a full water supply distributed as may be needed.

The shop is to be supplied with the following tools:

Two Universal boring, drilling, and milling machines, to be of sufficient size to mill around the edges of a plate 10 by 24 feet when set up on edge.

Three open side planers, to be of sufficient length to plane off the edges of plates 24 feet in length; to cut in both directions, and to have variable feed up to 1 inch; tool slide to have vertical adjustment of $3\frac{1}{2}$ feet and horizontal adjustment of 2 feet; to have heavy table to which work can be secured.

Two pit planers; width between housings or uprights at least 12 feet; traverse of tool 30 feet; to cut in both directions. To have two sets of uprights facing each other, and on each set is to be a planer cross slide carrying two cutting heads, which are to be independently self-feeding in all directions; the uprights to be strongly tied together at their upper ends and at their lower ends to be bolted to a slide or saddle of large bearing surface traversing the bed by means of a feed screw.

One cutting-off planer, to be of sufficient size to cut off the ends of plates up to 24 feet in length. Tool to consist of two massive beds, placed parallel to each other and securely bolted to solid foundation; two pairs of uprights, which are firmly united across their tops, and to be adjustable by power to any desired point on the upper side of these beds; uprights to be gibbed to the parallel beds on each side. Gibbed to the main faces of each pair of uprights will be a heavy cross slide, which is adjustable vertically by power and automatic feed through a distance of 4 feet; each cross slide to carry a planer head to plane crosswise of the machine, and having a traverse of 13 feet; cross slide to be fitted with worm gear, so that it can rotate on its axis and present the planing tool at any angle for bevel cutting; tool slide to have a traverse of 30 inches.

Two post planers, with slotter attachment, to work around edges of plates 10 by 24 feet, finished size.

Each to consist of a heavy column traversing on a massive bed, on one side of which is placed a heavy table to which work can be secured; on the face of the column a counterweighted saddle is to traverse vertically; saddle to be provided with tool slide arranged to cut in both directions, horizontally and vertically; slide to have horizontal movement of 20 inches; all feeds and movements to be by power and automatic.

One platen planer, 12 feet wide between uprights and to plane 25 feet in length; to have two saddles on cross slide and one saddle on each upright; one saddle to have power transverse cutting travel with quick return; platen to be driven by gearing and to have quick return motion. All saddles to be swiveled and adjustable by power.

One platen planer, 6 feet between uprights, to plane 20 feet in length; to have two saddles on cross slide; saddles to be swiveled and adjusted by power; platen to be driven by gearing and to have quick return.

Four universal drilling machines, to be at least 14 feet between uprights and to drill over surface of plate 10 by 24 feet; each to consist of a bed plate on which are bolted two rigid columns connected at top by a cross brace; a heavy counterweighted cross slide is to be gibbed to columns and to carry drilling head; cross slide to rotate by worm gear and drill head is to swivel; cross slide to be adjustable by

power and drill head by rack and pinion; spindle to have a traverse of 3 feet; work to be carried under drill spindle by truck running in track over bed plate.

Two radial drills, to be strong, heavy tools, with overreach of 6 feet, and to drill holes up to 2 inches in any direction; to have bed plate to which work can be secured.

Two circular planers to plane edges of plates up to 24 feet in length by 10 feet in width.

Each to consist of a massive bed on which a heavy saddle traverses by power carrying a disk 7 feet in diameter at cutting circle.

One lathe to swing 72 inches and take 50 feet between centers; to be a first-class, heavy, screw-cutting back-geared engine lathe; to have compound rest and power cross feed; all bearing surfaces to be large; to have adjustable bearings for spindle; lead screw to be used only for screw cutting.

One lathe to swing 48 inches and take 20 feet between centers; to be a first-class, heavy, screw-cutting back-geared engine lathe with taper attachment; to have compound rest and power cross feed; to have adjustable bearings for spindle and large bearing surfaces; lead screw to be used for screw cutting only.

Two emery grinders to grind off edges of plates 24 feet long, 10 feet wide, and 18 inches thick; to consist of a very heavy bed on which a carriage will be gibbed and travel automatically by power and be adjustable to any stroke within its range.

One trepanning tool to cut out test specimens; to consist of a bed on which a short column traverses by power; on the columns is a drilling head provided with automatic feed and hand motion; traverse of spindle to be 18 inches.

Besides the heavy tools specified above the following are required for repairs, making armor bolts, nuts, etc.:

Four roughing lathes for specimens.

Two finishing lathes for specimens, back geared.

Both the above to be about 12-inch swing and take 18 inches between centers.

Three lathes for armor bolts, to be specially made and very heavy; geared for threads 3–3½–4 to 1 inch; each lathe to have two sets of cutting tools and gauges for grinding them. All to have 27-inch swing, the beds to be 24–12 feet and 9 feet, respectively; one to have two extra lead screws for 3 and 3½ threads to the inch.

One lathe, 24 inches by 12 feet.

Two lathes, 16 inches by 10 feet.

Two lathes, 12 inches by 6 feet.

All the above lathes to be first-class modern screw-cutting, with taper attachment.

One planer, to take 20 by 20 inches by 4 feet.

Two milling machines.

One shaper, 18-inch stroke, 6 feet traverse.

One shaper, 12-inch stroke, 14-inch traverse.

One slotter, 30 inches stroke.

One slotter, 10 inches stroke.

One horizontal boring mill.

Two emery tool grinders.

Two drill presses.

One test cutter.

There will also be the necessary shafting, hangers, blocks and falls, hydraulic jacks, and hand tools of all descriptions.

ERECTING SHOP.

[Drawings 19 and 20, Appendix A.]

The erecting shop is shown on the plans accompanying the report.

It is to have a craneway extending the whole length of the building. On this craneway is to be an electric crane of 75 tons capacity, having speed of travel of 250 feet per minute, of trolley 100 feet, and of hoist 10 feet. The trolley is to have a second hoist fitted with a capacity of 15 tons and speed of 25 feet per minute.

A standard gauge railroad track will extend through the building close to one side.

The floor of the shop is to be made of heavy sleepers, bedded in rubble; on the sleepers will be secured heavy planks or balks, on which the armor plates may be set on edge.

Electric portable grinders will be supplied for truing the edges and butts of plates.

The shop will be lighted by arc lights.

A large number of slings, jacks, clamps, blocks, etc., is to be supplied.

BOILER HOUSE.

[Drawings 9, 10, and 18, Appendix A.]

The boiler house will be of the size and construction shown on the accompanying plans.

There will be 16 boilers, each of 250 horsepower, arranged as shown.

The furnaces will be supplied by mechanical stokers and have coal boxes and chutes arranged along their fronts. A railroad track is to run above the boxes so they can be filled directly from a car.

The boilers are to be of the water-tube type. They are to be constructed of straight tubes expanded into headers, which in turn are connected with steam and water drums. The headers must be forged, not cast.

The tubes immediately over the fire must not be less than 4 inches in diameter and at least No. 6 BWG in thickness. If smaller tubes are used in upper courses, they must not be less than 2 inches in diameter and No. 8 BWG in thickness. No screw joints will be allowed in fire or heating spaces.

The design of the boilers must be such as to insure perfect water circulation and allow the easy and quick removal and replacing of any tube.

Each boiler will be fitted with a spring safety valve, a stop valve, a eed-check valve, a blow-off valve, three gauge cocks, a glass water gauge (the latter to show an exposed length of 24 inches), and a steam pressure gauge. The boilers must be designed for a working pressure of 200 pounds per square inch above the atmosphere.

There will be two feed pumps, each of which is to be capable of supplying all the boilers when worked to their full capacity. The pumps are to be compound, outside packed, single-acting, duplex-plunger pumps. The water valves must be adapted for hot water, and must be readily accessible and the steam valves must be adjustable from outside the chest.

There will be a feed-water heater, through which the water will pass on its way from the pump to the boiler. The heating will be by live steam and the water of condensation will be fed into the suction side of the pump.

Ample provision must be made for the expansion of the steam pipes from the various boilers by slip joints and long easy bends.

There will be two smoke pipes, one on each side of the building. The inlets to the main duct must be in the direction of the draft, so that one or more boilers may not shut off another.

POWER PLANT.

[Drawing No. 11, Appendix A.]

1. The building will be as shown on the plans submitted. It will be lighted by arc lights, and will be fitted up with desk, workbench, 5-ton traveling crane, and all the gauges, meters, and other appliances necessary in a plant of this description.

2. Each generating set is to consist of two multipolar electric generators, of 200 K. W. capacity each, directly connected to a vertical, automatically governed, triple or quadruple expansion engine. At least three sets will be required.

3. Whatever style of engine is used must be of thoroughly modern design, with large bearing surfaces, automatic oiling gear, forged-steel columns, and all pins, keys, nuts, etc., readily accessible and secured against working loose. The engines and generators must run at full speed and output without heating, jar, or vibration. The high and first intermediate pressure cylinders will have piston valves; the other cylinders will have slide valves. Each cylinder will have a separate crank. The cut-off on the high-pressure cylinder will be variable, and will be controlled by a governor revolving with the shaft; the cut-off on the other cylinders will be fixed.

4. The generators to be of the direct-current, constant-potential type, each having a capacity of 200 K. W. at 115 volts, running at 120 revolutions per minute.

(NOTE.—As electricity is to be used for both light and power, it may be necessary to provide generators of different potential.)

5. All the motors for operating the machines and portable tools are also to be furnished.

BLACKSMITH SHOP.

[Drawing No. 21, Appendix A.]

The building will be of the size and construction shown on the accompanying plans, and will contain the following tools and appliances:

Ten smith's forges.

One steam hammer of 3,500 pounds weight, with special furnace and jib crane.

One steam hammer of 2,000 pounds weight, with special furnace and jib crane.

One steam hammer of 1,000 pounds and one of 500 pounds, each with special fires.

One press and two furnaces for making armor-bolt washers.

One combined punch and shears, to be driven by an electric motor attached to the machine.

One pressure blower, driven by an electric motor directly attached, of sufficient capacity to supply all the fires at the same time.

The shop will be lighted by arc lights, and a railroad track will run through on one side.

There will be an ample water supply distributed where required.

There will also be a full supply of appliances, such as anvils, swage blocks, sledges, hammers, and smith's tools of all descriptions.

A rack for bar iron and steel will be fitted on one side of the shop.

CARPENTER SHOP.

[Drawing No. 23, Appendix A.]

There will be a building, of the size shown on the plans, fitted up for a carpenter and pattern shop. It will contain the following tools: Two wood lathes, 2 band saws, 2 jig saws, 2 planing machines, 2 circular saws, 1 glue stand, 6 workbenches and vises.

The building will be properly heated and will be lighted by arc lights.

All the above tools to be operated by electric motor.

LOCOMOTIVE HOUSE.

[Drawing No. 22, Appendix A.]

There will be a locomotive house of the size and construction shown on the plan accompanying this report. It will have space for eight locomotives, with pits and drainage as shown.

It will be lighted by arc lights.

Sockets will also be provided for a number of portable incandescent lights, for use in making slight repairs and adjustments to the locomotives.

PHYSICAL AND CHEMICAL LABORATORY.

[Drawing No. 25, Appendix A.]

There will be a building of the general size and construction, as shown on the plans, to be fitted up for a physical and chemical laboratory.

The portion intended for a physical laboratory will contain testing machines, for specimens in compression, tension, and bending; a small lathe, a milling machine, a small planing machine, a drill press, and, in short, every convenience for preparing and testing such specimens of the armor plate, in its various stages and manufacture, as may be required.

There will be workbenches, tables, desks, lockers, and storerooms for the safe-keeping of specimens and material.

The building will be lighted by arc and incandescent lights, and will be heated by steam. It will be located near the office building, and will be separated from the chemical laboratory as shown on the plans.

That portion of the building designed for use as a chemical laboratory will be fitted up for and contain all the fittings and appliances of a thoroughly modern, first-class, well-equipped chemical laboratory, including furnaces, retorts, balances, tables, desks, lockers, etc.—in short, every requisite necessary for making rapid and accurate analyses of all substances entering into the construction of nickel-steel armor plate.

Two rooms of this building will be fitted for analyses by the micro-photographic process.

The building will be heated by steam, will be thoroughly well ventilated, and lighted by incandescent lights.

OFFICE BUILDING.

[Drawing No. 24, Appendix A.]

The office building will be a two-story structure, as shown. On the first fioor will be eight office rooms, together with a wash room, closets, etc.; on the second floor will be drawing room, blue-print room, photographic room, and storeroom, together with wash room, closets, etc.

The building will be lighted with incandescent lights, both fixed and portable; it will be heated by steam.

A full supply of office furniture, such as desks, chairs, tables, etc., must be furnished, together with drawing boards, tables, blue-print frames, etc.

All the windows must be furnished with shades.

ESTIMATES.

The following estimates are for the cost, exclusive of the land, of a plant capable of making and furnishing ready for the installment on board ship of 6,000 tons per year of nickel steel, face hardened, reforged armor. As the size of the largest single armor plate to be produced fixes the size and number of melting furnaces required, and the size of the forging and bending presses, which are about the most expensive parts of the plant, and as the melting furnaces and presses, thus determined, are capable of producing a much greater quantity of armor than herein required, it follows that the cost of a plant of increased or diminished capacity will not be in direct proportion to the greater or less output, but will be in proportion to the greater or less number of cementing furnaces and machine tools supplied.

These estimates are made without exact knowledge of the local conditions of the site that may be selected. No freight is included, and the foundations for buildings and tools are of sufficient depth to secure stability and permanence on good hardpan or gravel only. Nothing has been included for grading or for excavating, except so far as necessary for the proper construction of the plant. Should the site selected be of such a character as to require piling or deeper foundations than herein contemplated the cost may be increased. Five per cent has been allowed, however, for erecting and engineering expenses, and it is thought that 5 per cent additional allowance would cover all contingencies under the worst conditions that may be encountered.

Estimated cost of proposed Government Armor Factory.

Name of department.	Buildings, and foundations.	Machinery, furnaces, stacks, etc.	Totals.
Open-hearth department	$210,398.70	$331,519.35	$541,918.05
Forging and cementing shop	186,630.74	1,371,607.20	1,558,237.94
Bending and tempering shop	85,494.75	360,544.15	446,038.90
Machine shop	140,577.35	460,073.98	600,651.33
Erecting shop	67,761.78	26,700.00	94,461.78
Boiler house	44,074.60	75,500.00	119,574.60
Power plant	31,258.80	103,400.00	134,658.80
Blacksmith shop	13,070.89	19,341.10	32,411.99
Locomotive house	6,804.13	415.00	7,219.13
Carpenter shop	5,467.83	3,219.00	8,686.83
Office building	15,000.00	.....	15,000.00
Chemical laboratory	6,000.00	19,000.00	25,000.00
Physical laboratory	6,000.00	27,000.00	33,000.00
Railroad tracks and equipment	86,642.76	.....	86,642.76
Latrines	11,112.00	.....	11,112.00
Water supply, sewerage, etc	33,298.00	.....	33,298.00
Total	949,592.33	2,798,319.78	3,747,912.11

The details of these estimates are appended. (See Appendix C.)

NOTE.—No estimates have been received from abroad. Estimates on some of the machine tools, particularly the forge presses and large planers, were solicited from one of the largest firms in England, but this firm replied that it preferred to defer quoting prices until Congress should decide to establish the armor factory.

NECESSITIES, ADVANTAGES, AND DISADVANTAGES.

From the foregoing it will be seen that a plant capable of producing the steel differs from one designed to procure the ingots by purchase only in the open-hearth department, and that the former necessitates a greater original outlay of $519,133, the estimate for such a department exclusive of the cast-iron foundry.

The advantages of establishing a plant capable of producing the steel may be enumerated as follows:

1. The ingots used may be produced by the armor factory of uniform quality and excellence, and as needed. It is thought that the competition among different firms to supply ingots at lowest prices would possibly result in getting inferior ingots, or such as would just pass inspection only, and that any resulting inferiority in the armor plates would naturally be attributed to the subsequent treatment at the armor factory.

2. It would enable the Government plant to improve or change the character of its steel as indicated by the progress of the art, and to experiment also with that end in view.

3. It would avoid the necessity and cost of transporting ingots of excessive weight, with sink heads and discard material attached, from the steel works to the armor factory.

4. It would avoid delays and uncertainties incident to the advertisement for ingots, and the inspection, purchase, and delivery of ingots.

5. It would increase the number of sites suitable for the plant by avoiding the necessity of locating it in a district where the steel industry is already well established.

The disadvantages of such a plant, the avoiding of which may be regarded also as the advantages of a plant designed to purchase the ingots, are:

1. Greater first cost, to the extent of $519,133.

2. Greater force of labor, both skilled and unskilled, necessary to make open-hearth steel ingots.

The board considers that the capacity to produce the steel ingots is so important to the successful and economic administration of an armor factory that it does not recommend an establishment designed to obtain the ingots by purchase. A casting department for the molds, anvils, and such castings as need occasional replacement, is necessary in either case, and can be profitably combined with an open-hearth steel plant as herein outlined.

In view of the advantages above mentioned, and notwithstanding the greater first cost of the establishment, the board recommends that the Government armor factory include a plant for the production of open-hearth steel ingots.

NEW PROCESSES.

The board has received several communications in regard to new processes for making both steel and armor. As none of these were accompanied by any tangible data by which the board could form exact estimates of their value for making armor, the writers were informed that "owing to the short time allowed the board to make its report it would be impossible to consider any methods for the manufacture of steel for armor except those in general use at this time."

The board has learned, however, from the press and from reliable armor experts, that certain improvements in the methods of manufacture, not fully known in this country, have been introduced abroad,

which greatly improve the ballistic properties of plates. The board has also obtained some knowledge of an experimental armor plate, in process of making in this country by a method quite different from the Harvey cementation process, from which the manufacturers seem to expect good results. These facts are mentioned to show that an armor plant equipped as provided in this report must be capable of change or expansion to suit the introduction of new improvements, looking to increased ballistic properties or to decreased cost of production. The board can not say that the introduction of such new improvements in the future will radically change the character of the plant here submitted.

Private firms engaged in this industry and zealously guarding the reputation of their products, both at home and abroad, may readily obtain, by purchase, the secrets and patent rights of new improvements, and their experts are constantly studying how to improve the quality of their plates and are assiduously experimenting to prove the value of new ideas. From an economical point of view alone, this ability to produce as good as the best is very essential to the success of a Government armor factory. Any change in method that improves the ballistic properties of armor plate has a very serious bearing upon the science of naval architecture, but it is evident that in any factory which may be established it must be held in contemplation that changes will have to be made therein from time to time to keep it up to date in its processes and products.

Although a proving ground for testing armor plates is not essentially a part of an armor plant, we take this opportunity to recommend the establishment of a proving ground, at or near the site of the proposed armor factory, of sufficient capacity to permit of the necessary tests, both for final acceptance and for experimentation. Aside from its value in experiment, this would eventually result in considerable economy, covering transportation of plates and the utilization of fragments in producing new plates.

PRACTICABILITY.

In accordance with your views that the Congress would wish from the board a statement in the rough of the practicability of putting up an armor plant, we respectfully submit the following considerations:

1. An armor factory comprises essentially a collection of special furnaces, heavy machine tools and appliances that are not needed in any other class of work, and a class of labor specially skilled in the business.

2. A Government armor factory not connected with an establishment engaged in other branches of the steel industry would depend for its success and economic administration upon a constant demand for an output nearly approaching its full capacity.

3. If the Government should establish an armor factory the efficient and economic maintenance or working of that factory would necessarily depend upon a constant yearly appropriation for ships to be provided with armor, because the armor produced at any time must be specially designed for and fitted to those ships. Any failure to appropriate for such ships in any one year would require the cessation of work and the laying off, indefinitely, of the skilled experts and laborers that had been trained to this industry. A resumption of work at a later period would require the training, at a considerable expense, of a new set of men. In the meantime the progress of the art would perhaps have been such

that difficult and radical changes would be required, which under continuous working might have been gradually and easily made.

SITES.

The board in its instructions was not charged with the selection of a site or location for the armor factory. It, however, appends to this report a list of the places recommended to the board as sites, and showing also the names of the persons so recommending them. (Appendix D.)

Respectfully submitted.

J. A. HOWELL,
Commodore, United States Navy, President Armor Factory Board.

A. H. MCCORMICK,
Captain, United States Navy.

MORDECAI T. ENDICOTT,
Civil Engineer, United States Navy.

JAMES H. PERRY,
Chief Engineer, United States Navy.

F. F. FLETCHER,
Lieutenant, United States Navy.

A true copy:

W. IRVING CHAMBERS,
Lieutenant, United States Navy, Recorder.

LIST OF APPENDIXES.

APPENDIX A.—Drawings, as follows:

No. 0. General arrangement of shops. Scale $\frac{1}{32}$ inch = 1 inch.
1. Open-hearth building, plan. Scale $\frac{1}{8}$ inch = 1 inch.
2. Open-hearth building, cross section. Scale $\frac{1}{8}$ inch = 1 inch.
3. Open-hearth building, side elevation and end view. Scale $\frac{1}{8}$ inch = 1 inch.
4. Forging and cementing shop, plan. Scale $\frac{1}{8}$ inch = 1 inch.
5. Forging and cementing shop, section through press. Scale $\frac{1}{8}$ inch = 1 inch.
6. Forging and cementing shop, section through press pump. Scale $\frac{1}{8}$ inch = 1 inch.
7. Forging and cementing shop, side elevation. Scale $\frac{1}{8}$ inch = 1 inch.
8. Forging and cementing shop, end view. Scale $\frac{1}{8}$ inch = 1 inch.
9. Boiler house, plan. Scale $\frac{1}{8}$ inch = 1 inch.
10. Boiler house, section and end view. Scale $\frac{1}{8}$ inch = 1 inch.
11. Power house, plan section and end view. Scale $\frac{1}{8}$ inch = 1 inch.
12. Railroad approaches to open-hearth plant. Scale $\frac{1}{8}$ inch = 1 inch.
13. Bending and tempering shop, plan. Scale $\frac{1}{8}$ inch = 1 inch.
14. Bending and tempering shop, section through press. Scale $\frac{1}{8}$ inch = 1 inch.
15. Bending and tempering shop, section through tank and end view. Scale $\frac{1}{8}$ inch = 1 inch.
16. Machine shop, plan. Scale $\frac{1}{8}$ inch = 1 inch.
17. Machine shop, end view and side elevation. Scale $\frac{1}{8}$ inch = 1 inch.
18. Detail of stacks. Scale $\frac{1}{4}$ inch = 1 foot.
19. Erecting shop, plan and side elevation. Scale $\frac{1}{8}$ inch = 1 foot.
20. Erecting shop, section and end view. Scale $\frac{1}{8}$ inch = 1 foot.
21. Blacksmith shop, plan, section, and views. Scale $\frac{1}{8}$ inch = 1 foot.
22. Locomotive house, plan, section, and views. Scale $\frac{1}{8}$ inch = 1 foot.
23. Carpenter shop, plan, section, and views. Scale $\frac{1}{8}$ inch = 1 foot.
24. Office, plans, section, and views. Scale $\frac{1}{8}$ inch = 1 foot.
25. Laboratory, plans, section, and views. Scale $\frac{1}{8}$ inch = 1 foot.
26. Heating furnace, plans and section. Scale $\frac{3}{8}$ inch = 1 foot.
27. Car-bottom furnace (14 by 22 feet), details. Scale $\frac{3}{8}$ inch = 1 foot.
28. Car-bottom furnace (14 by 30 feet), details. Scale $\frac{3}{8}$ inch = 1 foot.

APPENDIX A.—Drawings, as follows—Continued.

No. 29. Reheating furnace, details. Scale $\frac{3}{8}$ inch = 1 foot.
30. 45-ton ladle and transfer trucks, details. Scale $1\frac{1}{2}$ inches = 1 foot.
31. 75-ton ladle and transfer trucks, details. Scale $1\frac{1}{2}$ inches = 1 foot.
32. 7 by 12 by 36 feet tempering furnace, details. Scale $\frac{3}{8}$ inch = 1 foot.
33. Detail of truss, 130-foot building. Scale $\frac{1}{2}$ inch = 1 foot.
34. Detail section of open-hearth building. Scale $\frac{3}{8}$ inch = 1 foot.
35. Siemens gas producers. Scale $\frac{3}{4}$ inch = 1 foot.
36. Forging press. Scale $\frac{3}{8}$ inch = 1 foot.
37. Bending press. Scale $\frac{3}{4}$ inch = 1 foot.

APPENDIX B.—Specifications.

APPENDIX C.—Details of estimates.

APPENDIX D.—List of places recommended to the board as sites.

APPENDIX E.—Form of advertisement for proposals.

APPENDIX F.—Record of proceedings.

APPENDIX G.—Photographs of armor-factory facilities.

a. Of the Bethlehem Iron Company.
b. Of the Carnegie Steel Company.
c. Of the Illinois Steel Company.

APPENDIX A.

(38 illustrations.)

ERRATA.

In reproducing the drawings for binding it was necessary to change the scales, and those given on pages 22 and 23 are therefore incorrect. The following list should be substituted:

APPENDIX A.—Drawings as follows:

No. 0. General arrangement of shops. Scale $\frac{1}{32}$ inch = 2 feet.
1. Open-hearth building, plan. Scale $\frac{1}{8}$ inch = 2 feet.
2. Open-hearth building, cross section. Scale $\frac{1}{8}$ inch = 2 feet.
3. Open-hearth building, side elevation and end view. Scale $\frac{1}{8}$ inch = 2 feet.
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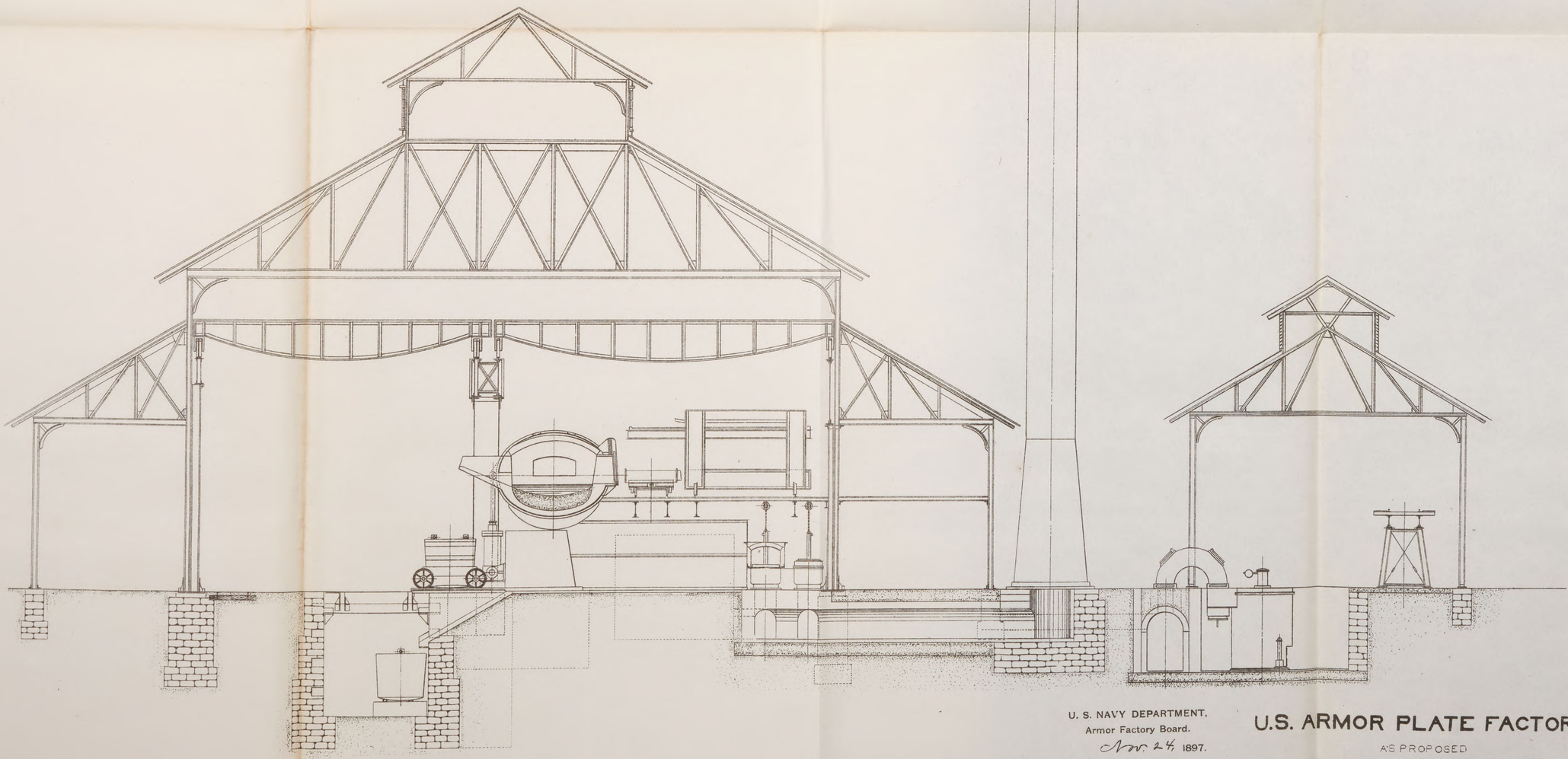
37. Bending press. Scale $\frac{3}{4}$ inch = 2 feet.

E $\frac{1}{32}$" = 2FT



U. S. NAVY DEPARTMENT.
Armor Factory Board.
Nov. 24, 1897.
W. Berry Chambers,
LIEUT. & RECORDER.

U.S. ARMOR PLATE FACTORY

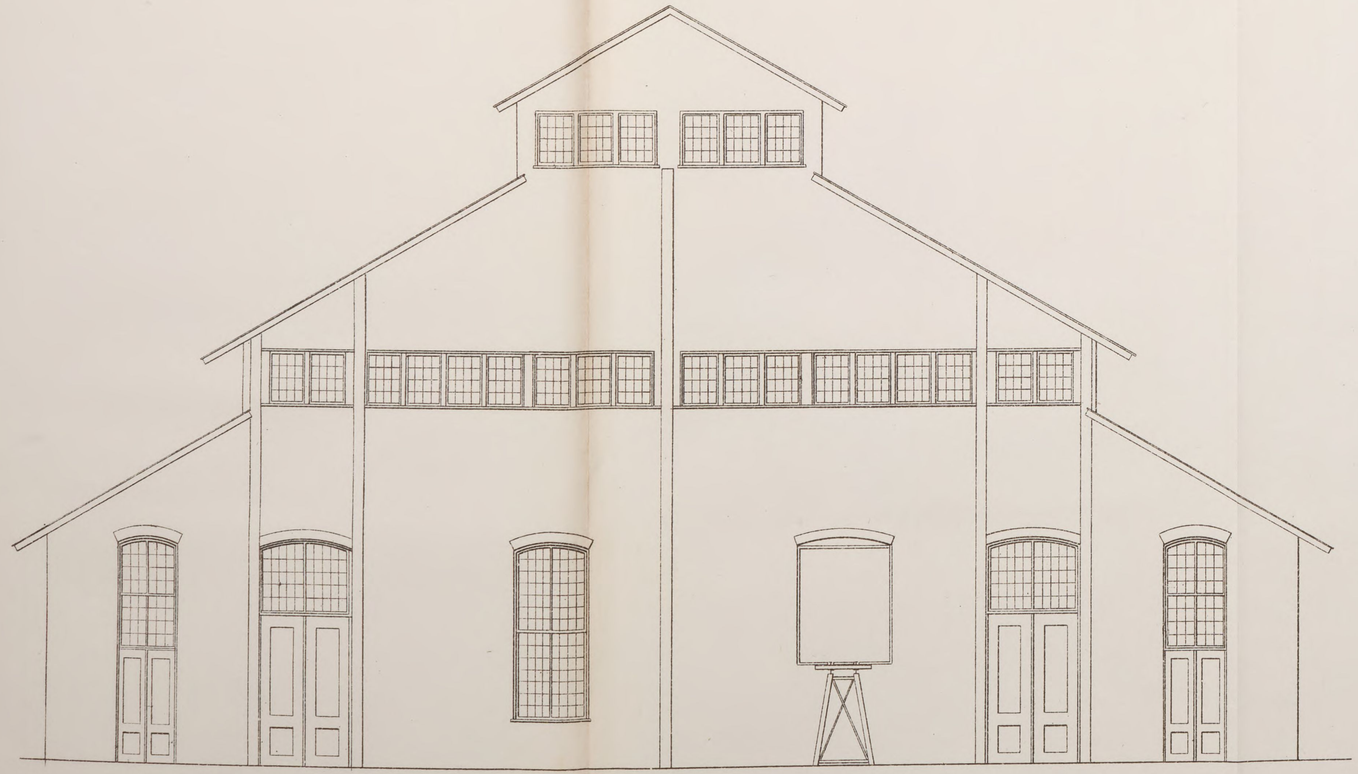
AS PROPOSED

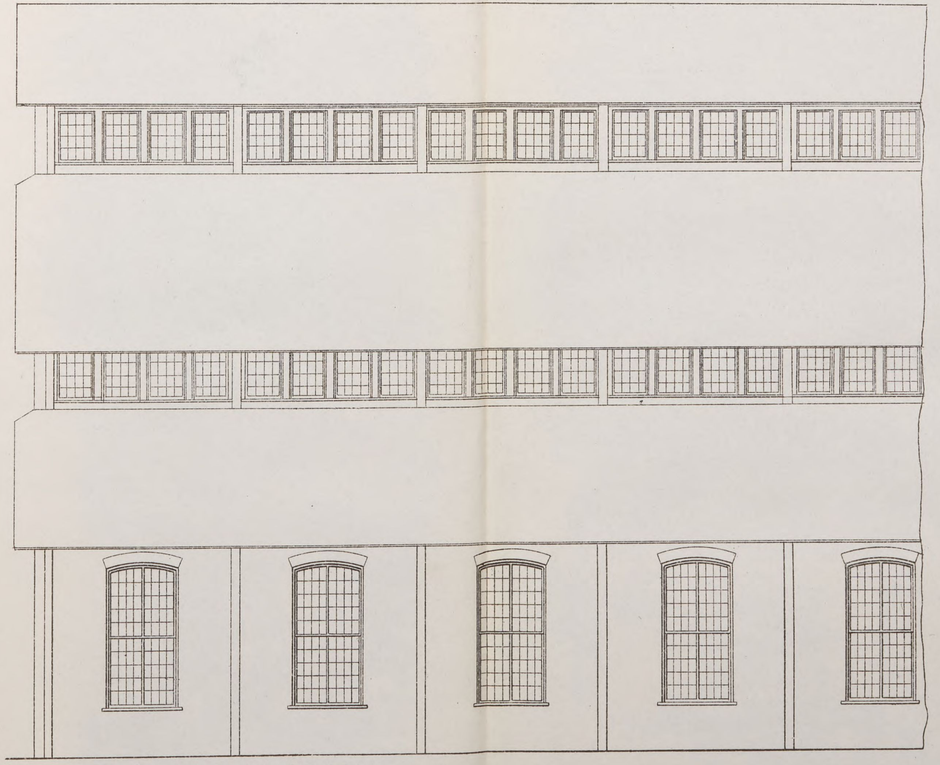
OPEN HEARTH BUILDING

SCALE 1/8" = 2FT

2

APPENDIX A.





U. S. NAVY DEPARTMENT,
Armor Factory Board.
Nov. 24, 1897.
W. Berry Chambers,
LIEUT. & RECORDER.

U.S. ARMOR PLATE FACTORY

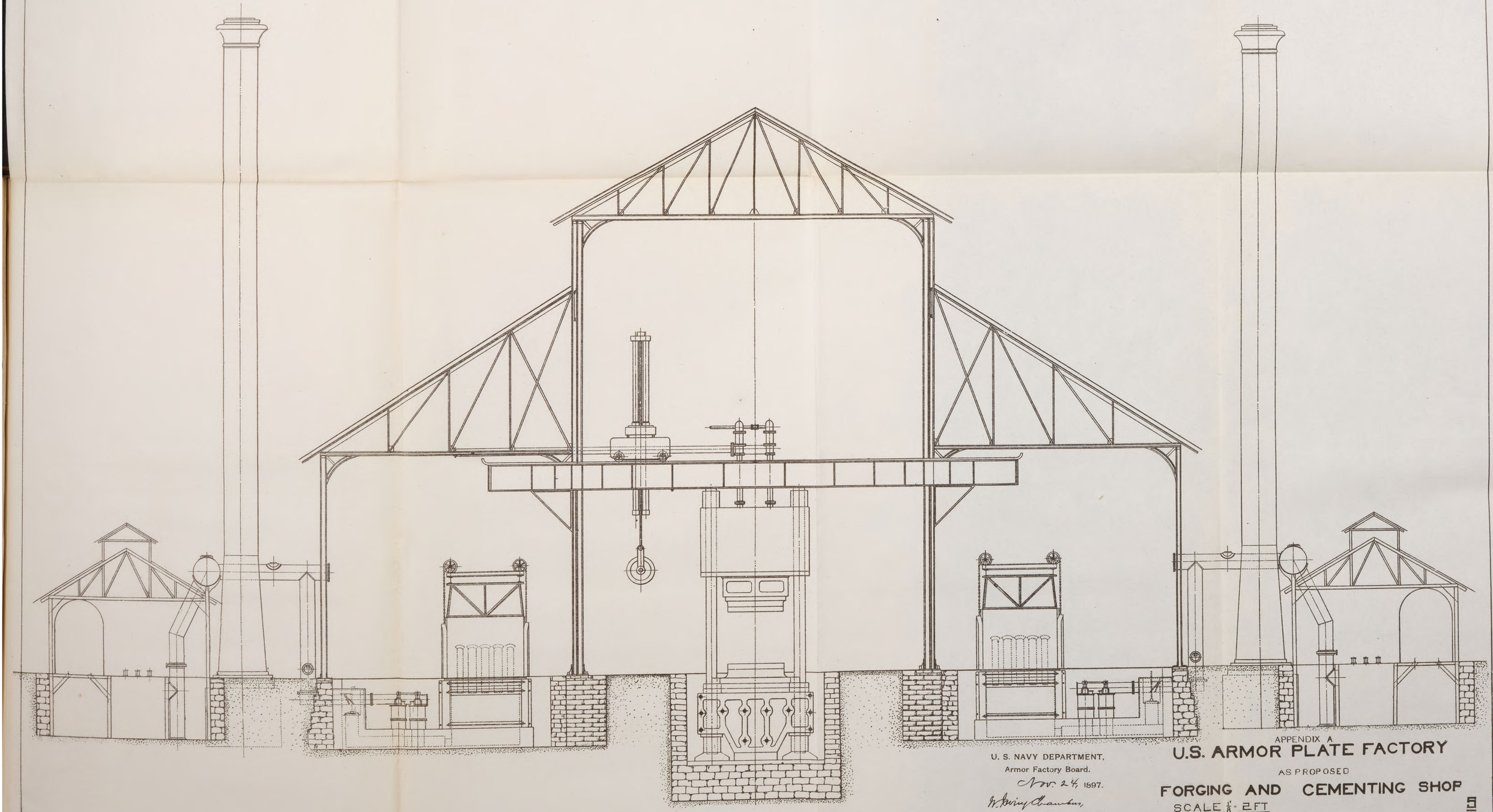
AS PROPOSED

OPEN HEARTH BUILDING

SCALE $\frac{1}{8}$"=1FT

3

H Doc. 95 55 2



U. S. NAVY DEPARTMENT,
Armor Factory Board.
Nov. 24, 1897.
W. Berry Chambers,
LIEUT. & RECORDER.

APPENDIX A

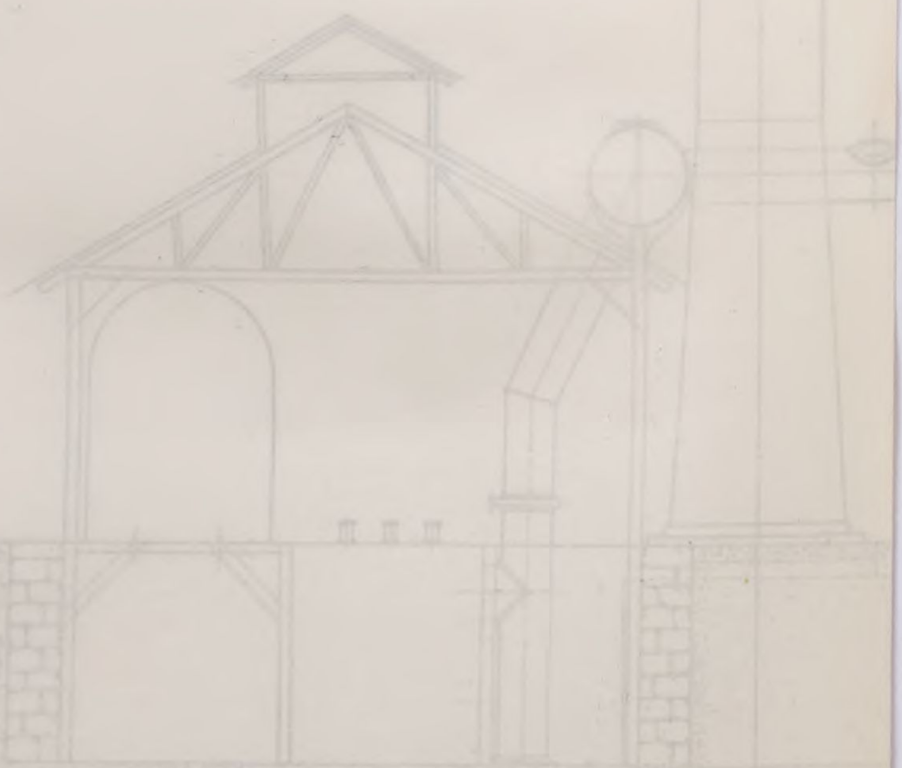
U.S. ARMOR PLATE FACTORY

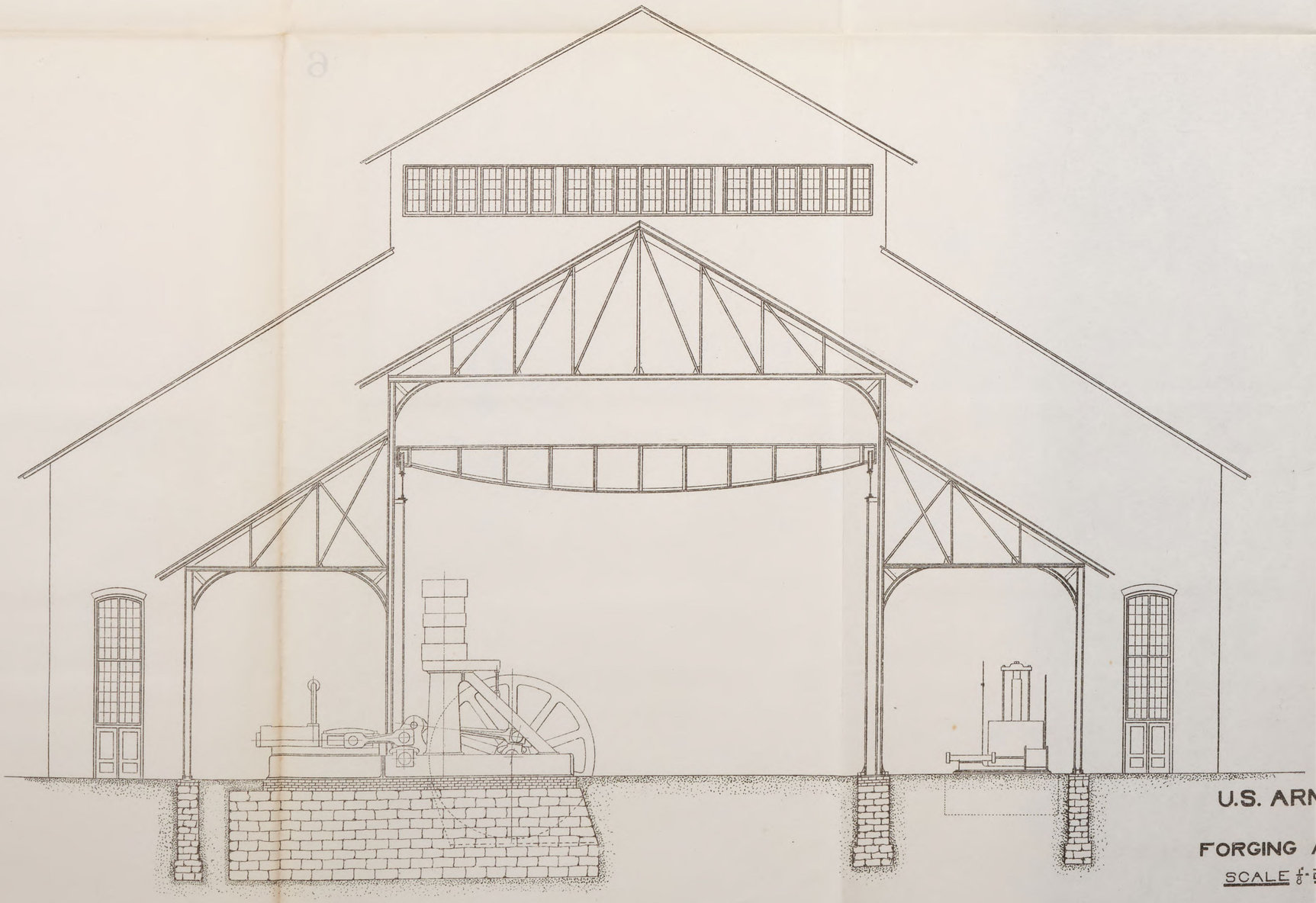
AS PROPOSED

FORGING AND CEMENTING SHOP

SCALE 1/8 - 2 FT

5





U. S. NAVY DEPARTMENT,
Armor Factory Board.
Nov. 24, 1897.
W. Irving Chambers,
LIEUT. & RECORDER.

APPENDIX A.

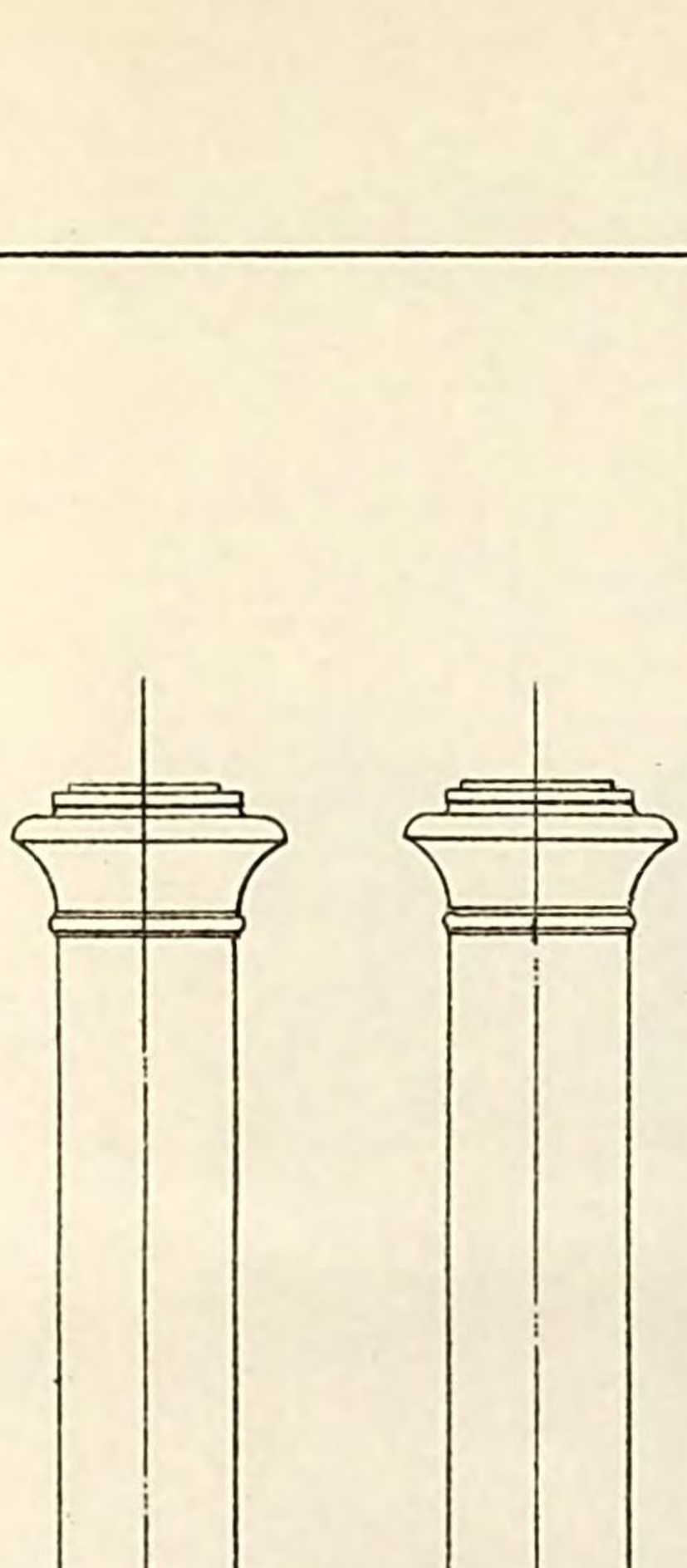
U.S. ARMOR PLATE FACTORY

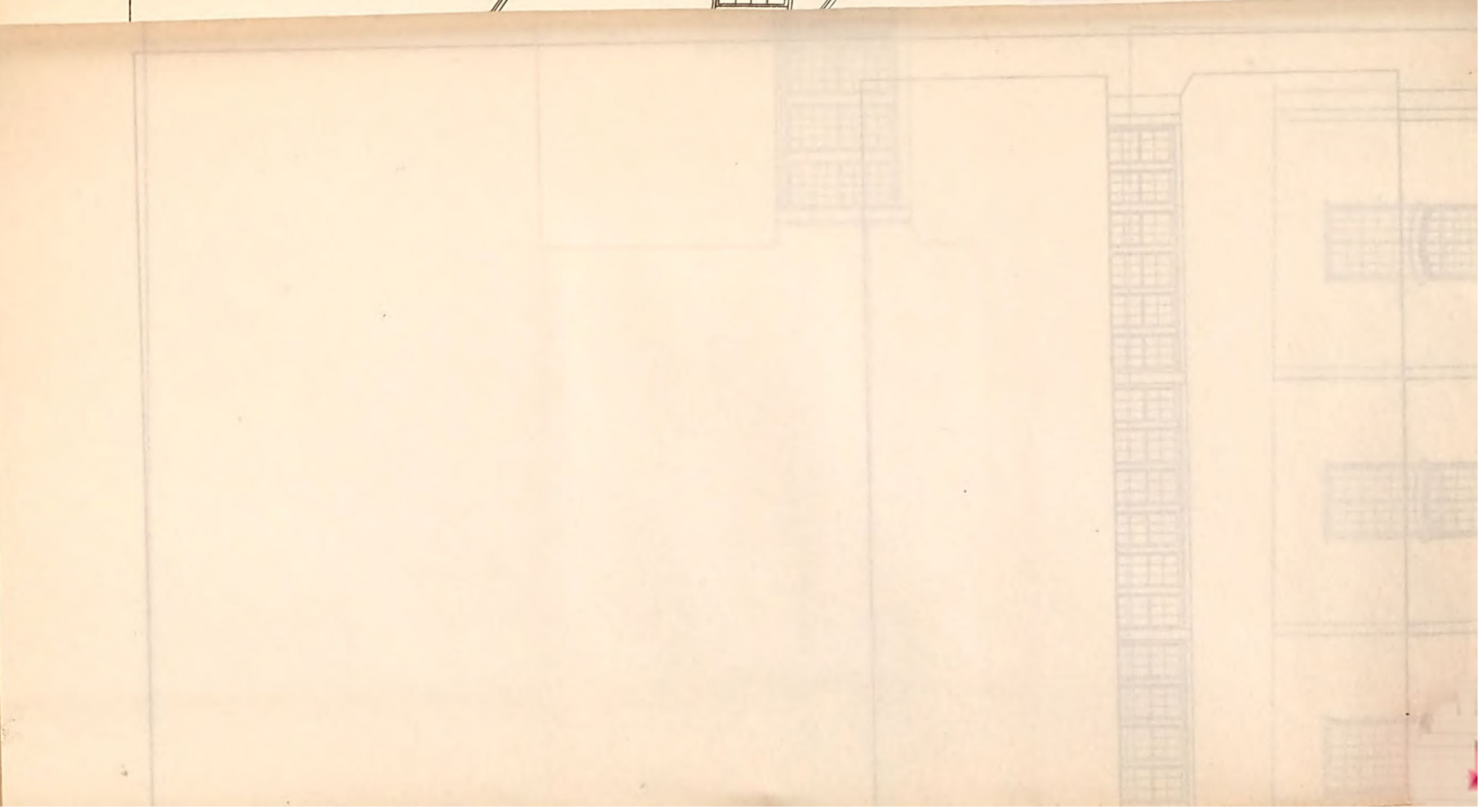
AS PROPOSED

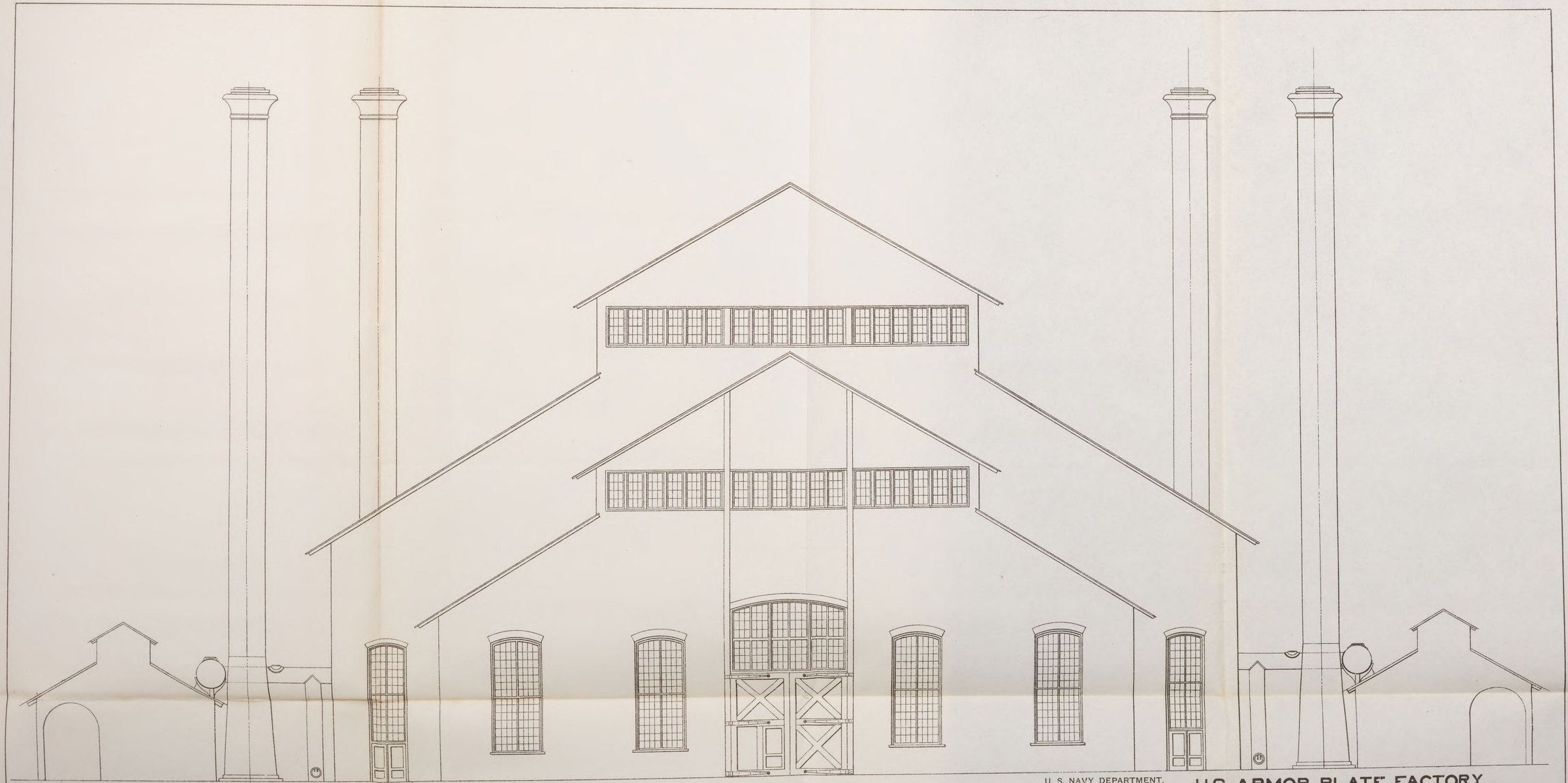
FORGING AND CEMENTING SHOP

SCALE $\frac{1}{8}$ = 1 FT

5







U. S. NAVY DEPARTMENT,
Armor Factory Board.
Nov 24 1897
W. Irving Chambers,
LIEUT. & RECORDER.

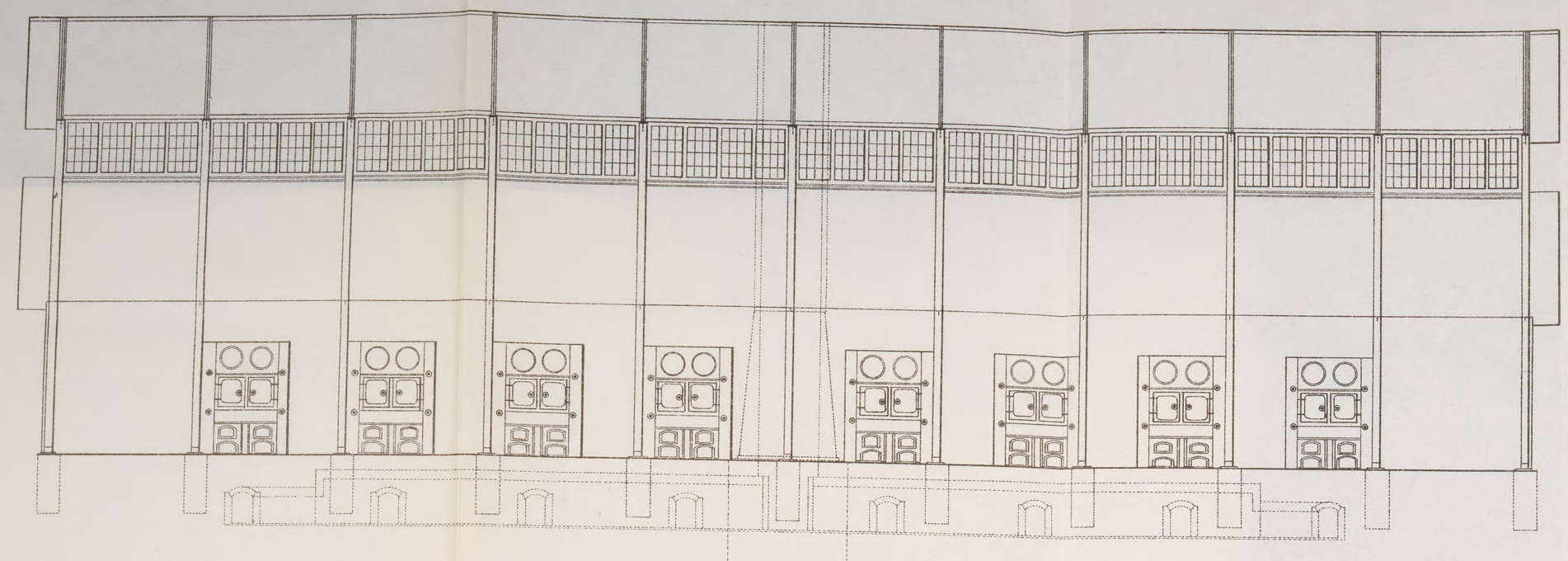
U.S. ARMOR PLATE FACTORY

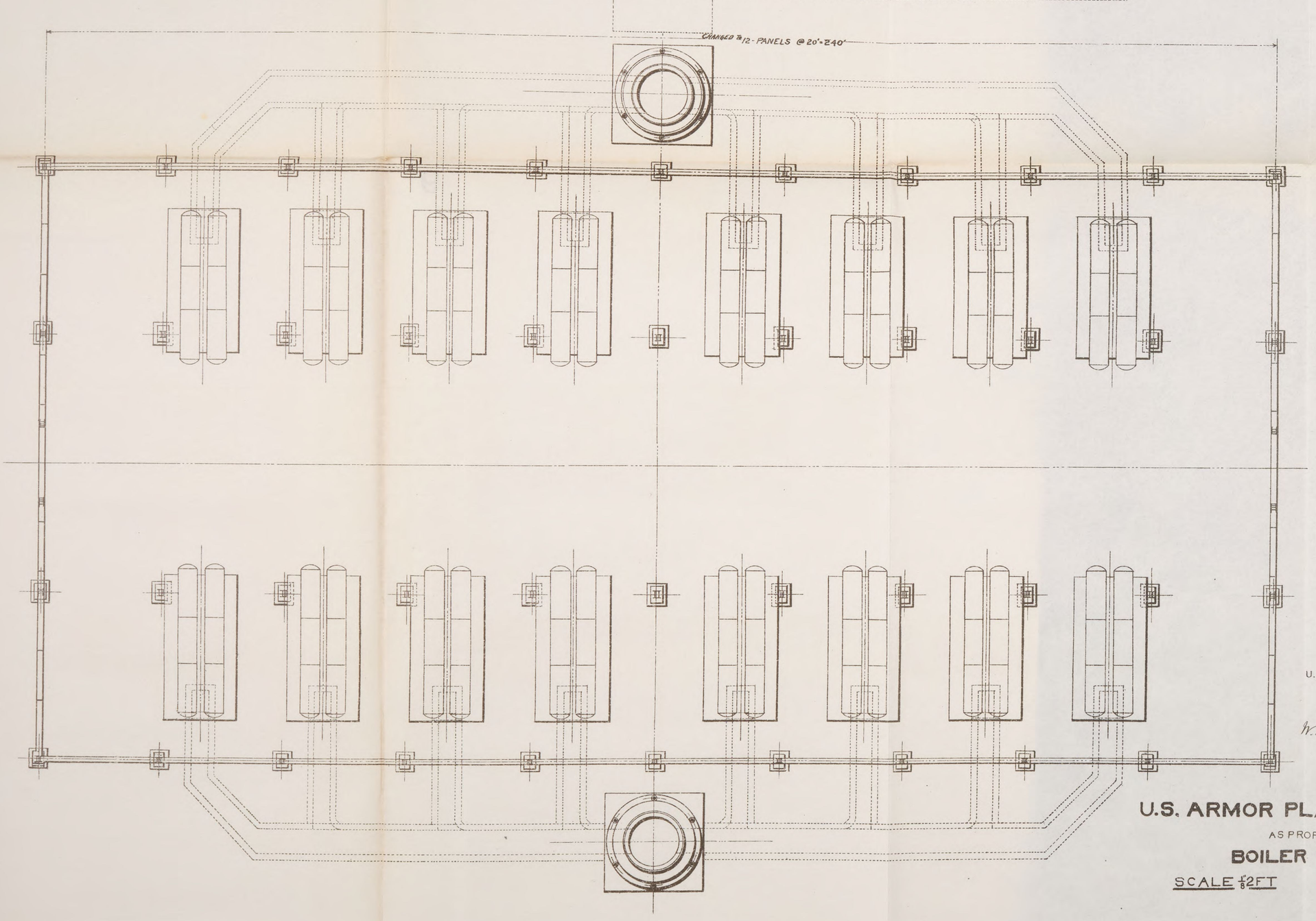
AS PROPOSED

FORGING AND CEMENTING SHOP

SCALE 1/8 2 FT.

APPENDIX A. 8





U. S. NAVY DEPARTMENT,
Armor Factory Board.
Nov 24, 1897.
W. Swift Chambers,
LIEUT. & RECORDER.

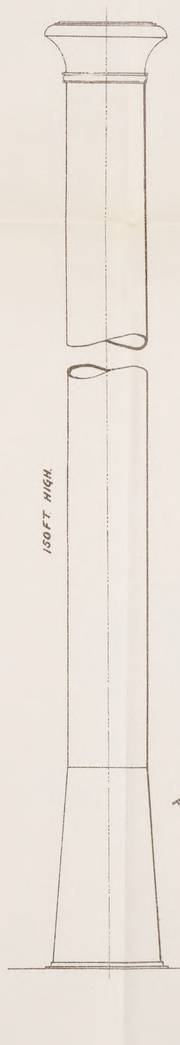
APPENDIX A.

U.S. ARMOR PLATE FACTORY

AS PROPOSED

BOILER HOUSE

SCALE 1/8 2FT



U. S. NAVY DEPARTMENT.
Armor Factory Board.
Nov. 24, 1897.
W. Barry Chambers,
LIEUT. & RECORDER.

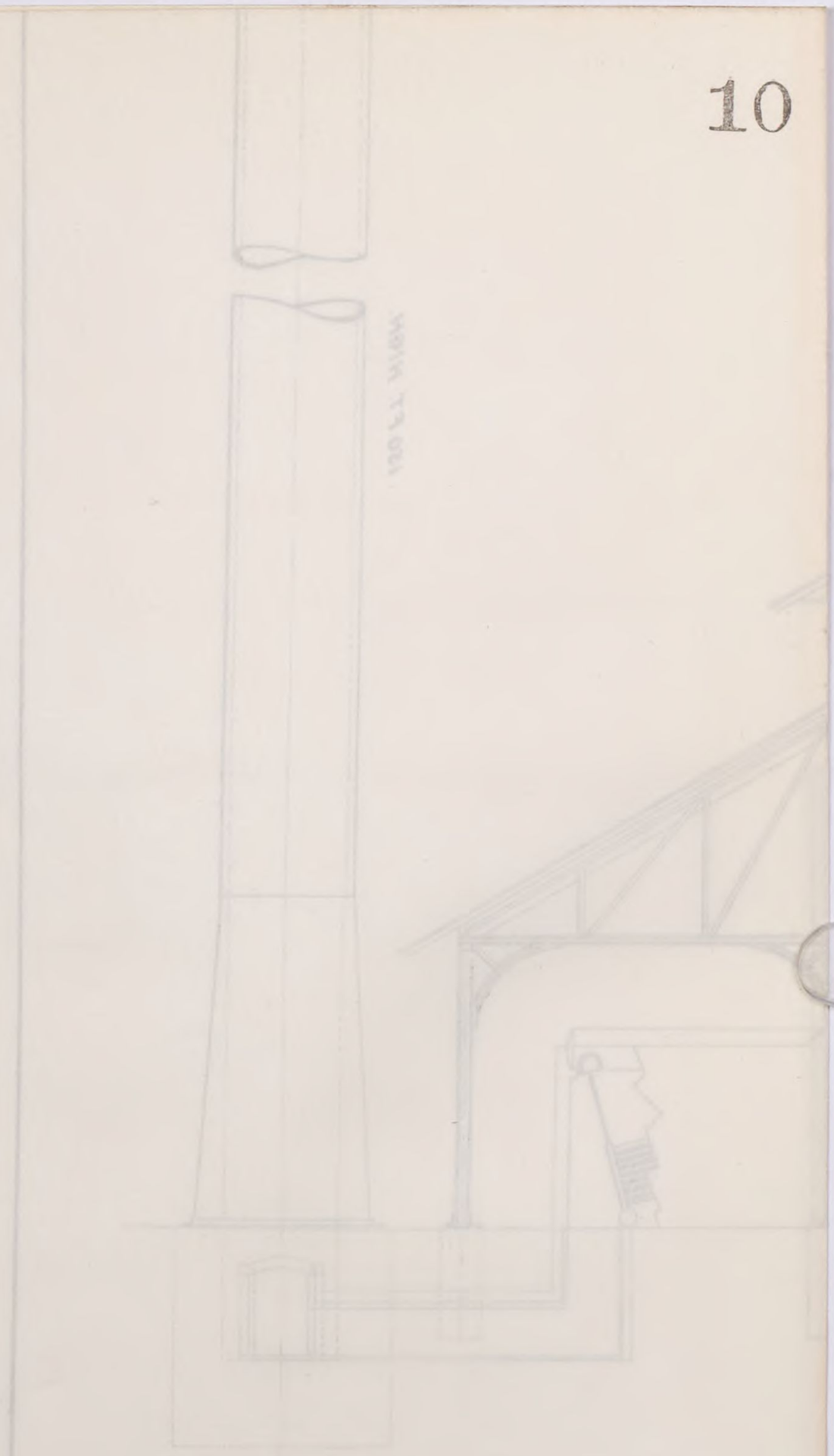
U.S. ARMOR PLATE FACTORY

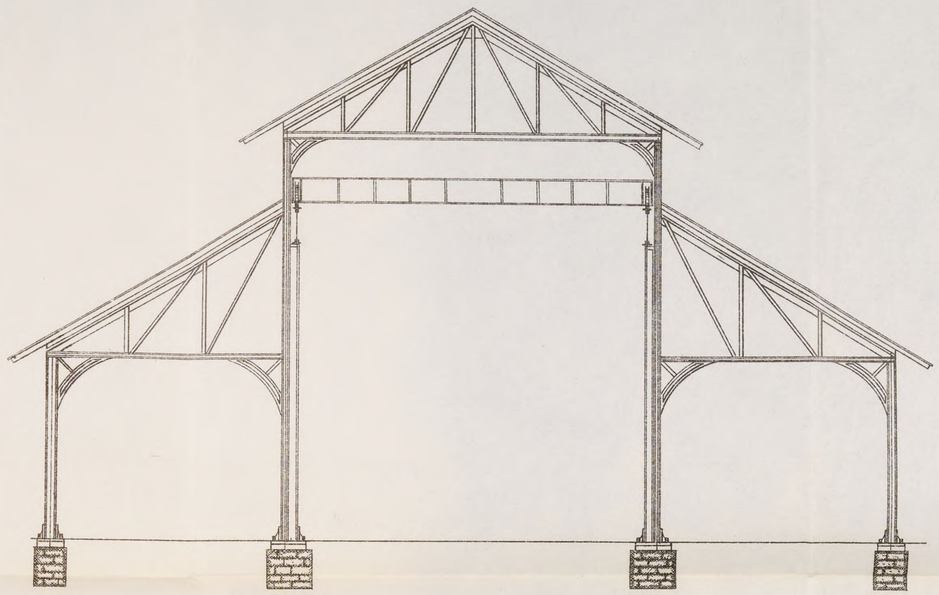
AS PROPOSED

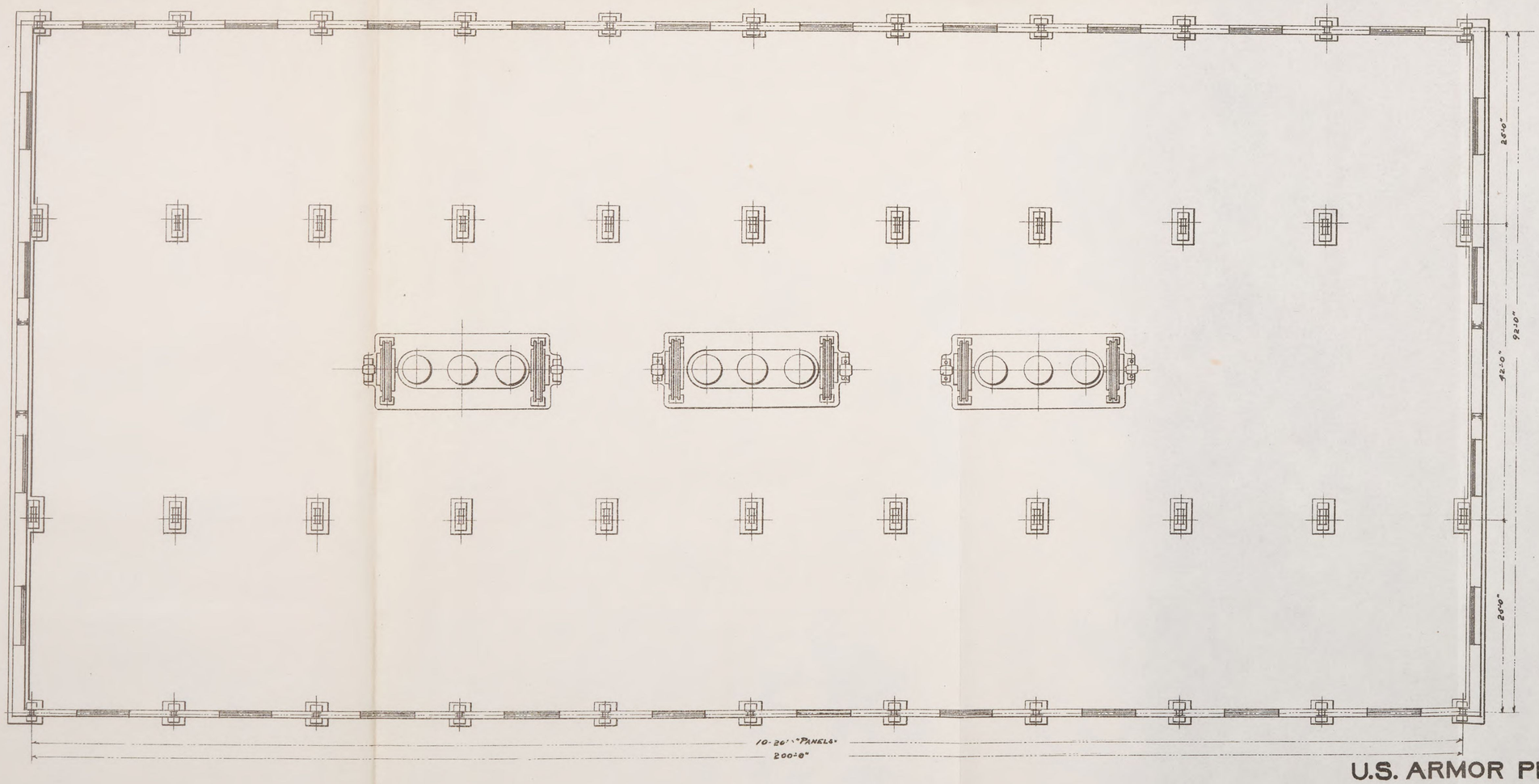
BOILER HOUSE

SCALE $\frac{1}{8}$-2FT

10







U. S. NAVY DEPARTMENT
Armor Factory Board.
Nov. 24, 1897.
W. Bering Cranston,
LIEUT. & RECORDER.

APPENDIX A.

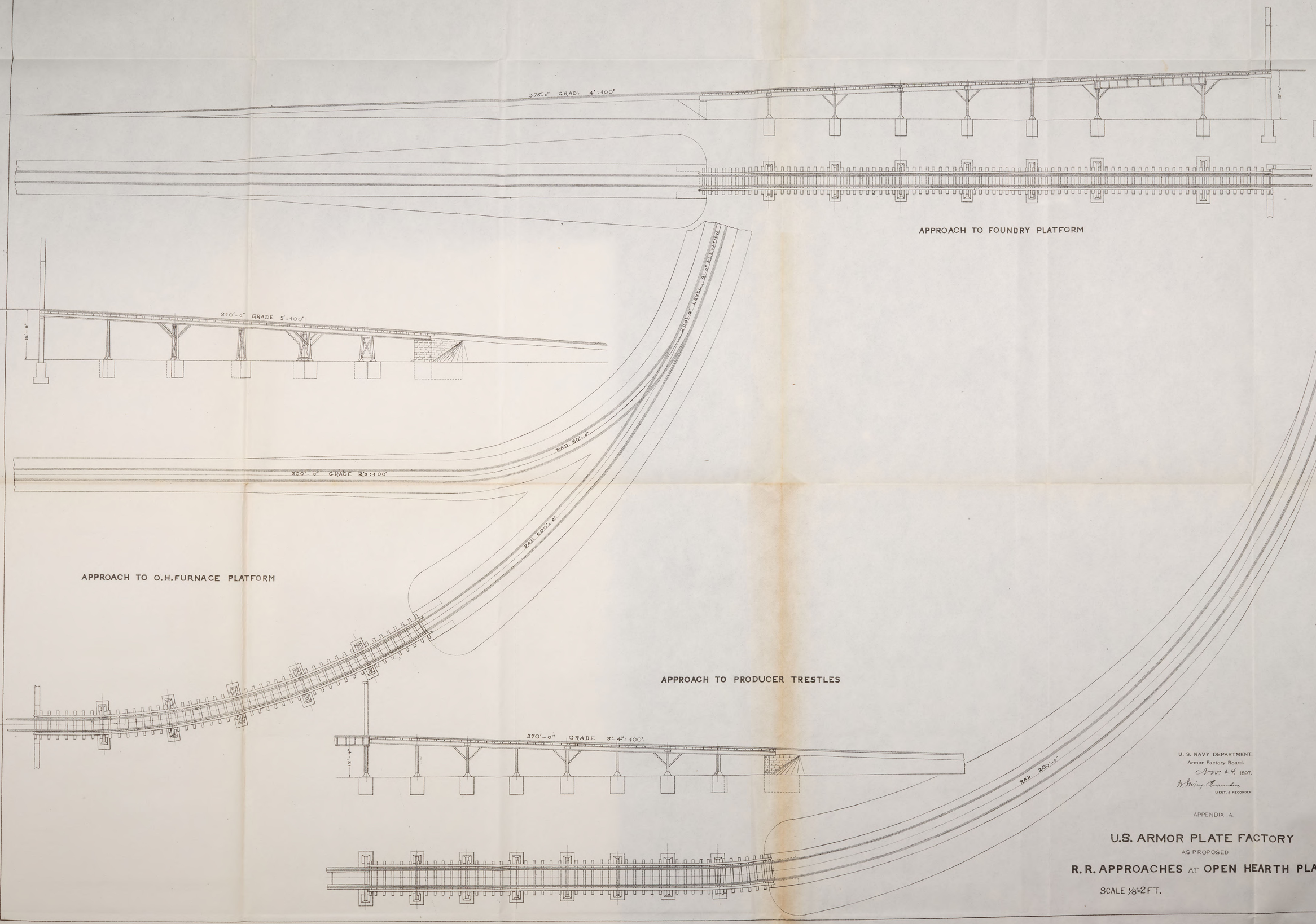
U.S. ARMOR PLATE FACTORY

AS PROPOSED

POWER HOUSE

SCALE $\frac{1}{8}$ · 2 FT

11



U. S. NAVY DEPARTMENT.
Armor Factory Board.
NOV 24 1897.
W. Irving Chambers,
LIEUT. & RECORDER.

APPENDIX A.

U.S. ARMOR PLATE FACTORY

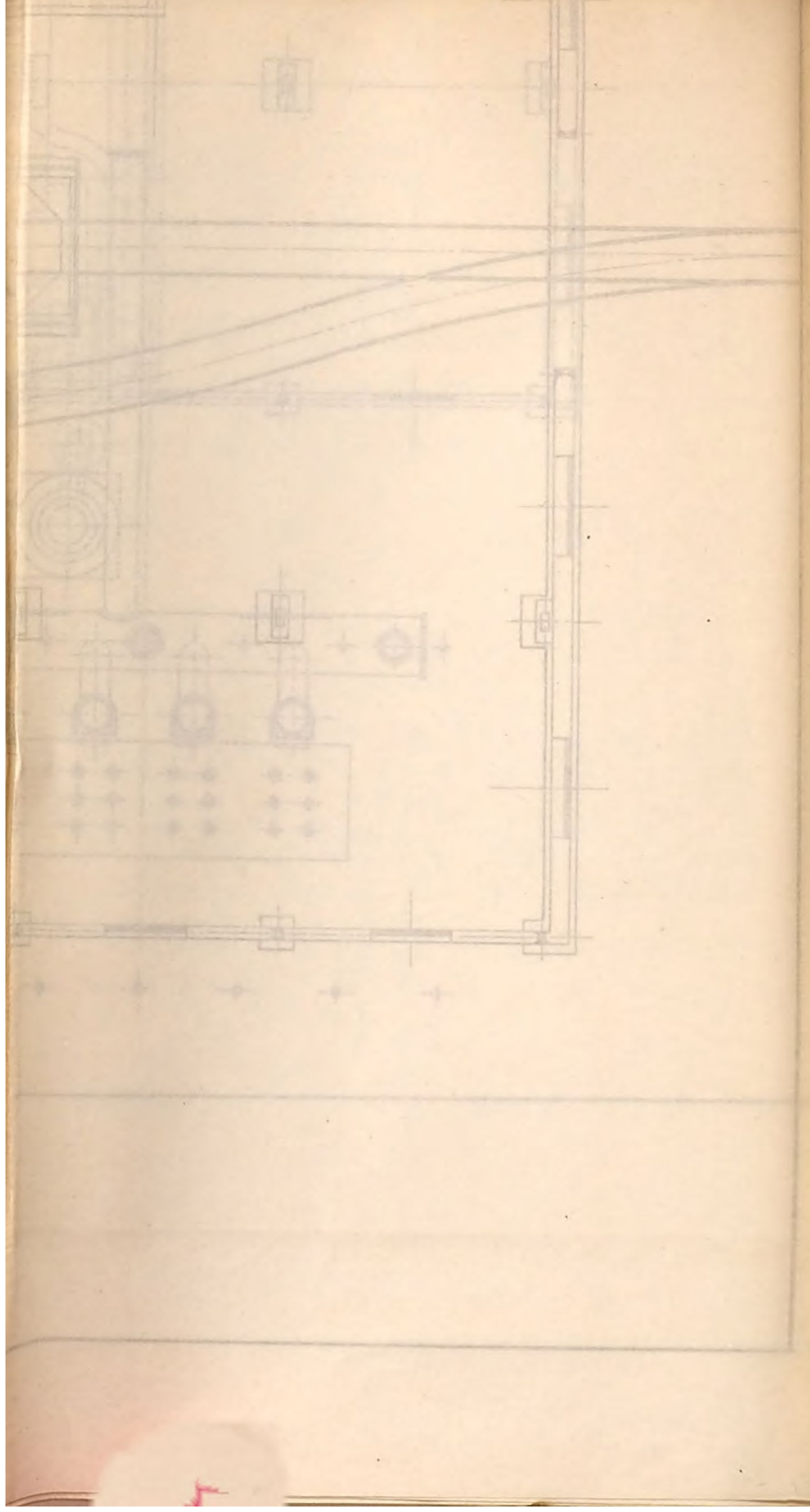
AS PROPOSED

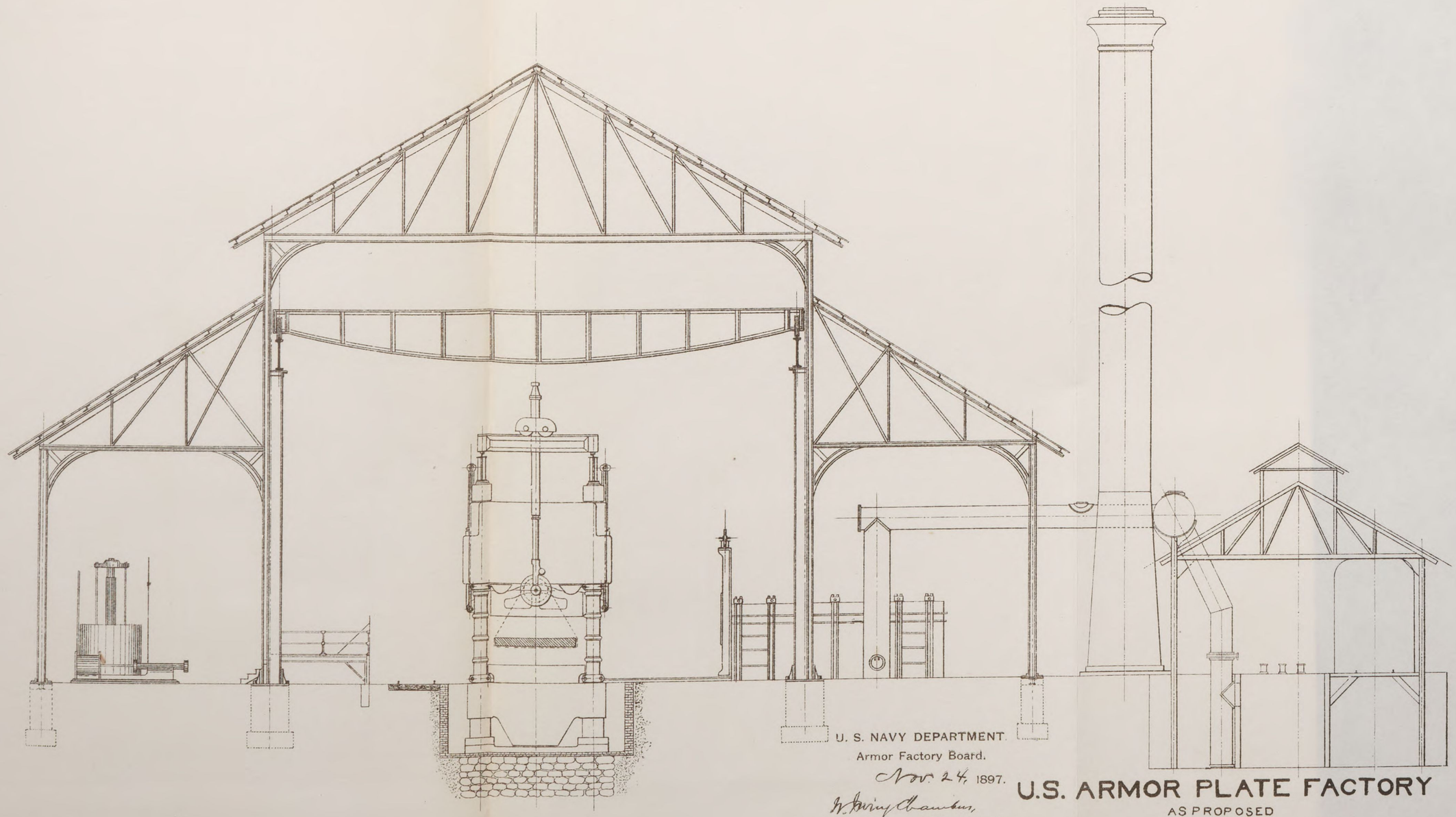
R. R. APPROACHES AT OPEN HEARTH PLANT

SCALE 1/8 = 2 FT.

12

H Doc. 55 2





U. S. NAVY DEPARTMENT.
Armor Factory Board.
Nov. 24, 1897.
W. Berry Chambers,
LIEUT. & RECORDER.

U.S. ARMOR PLATE FACTORY

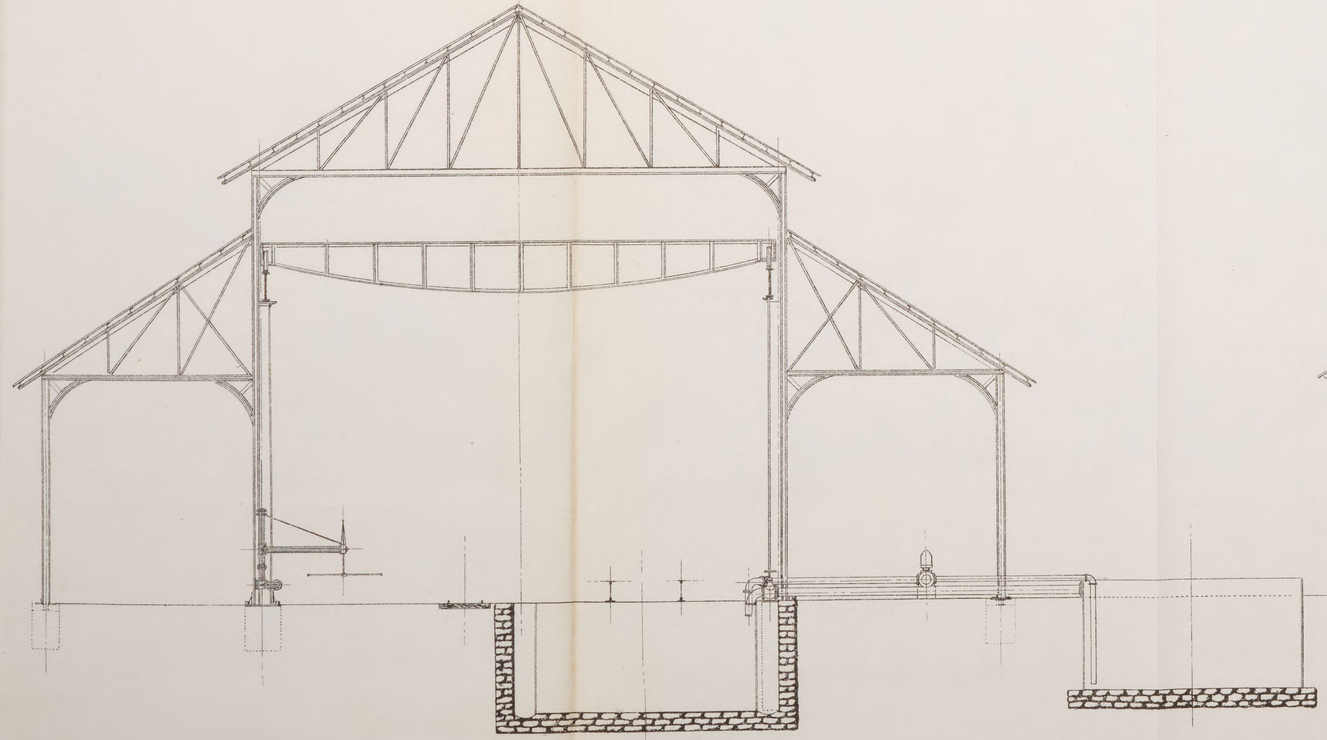
AS PROPOSED

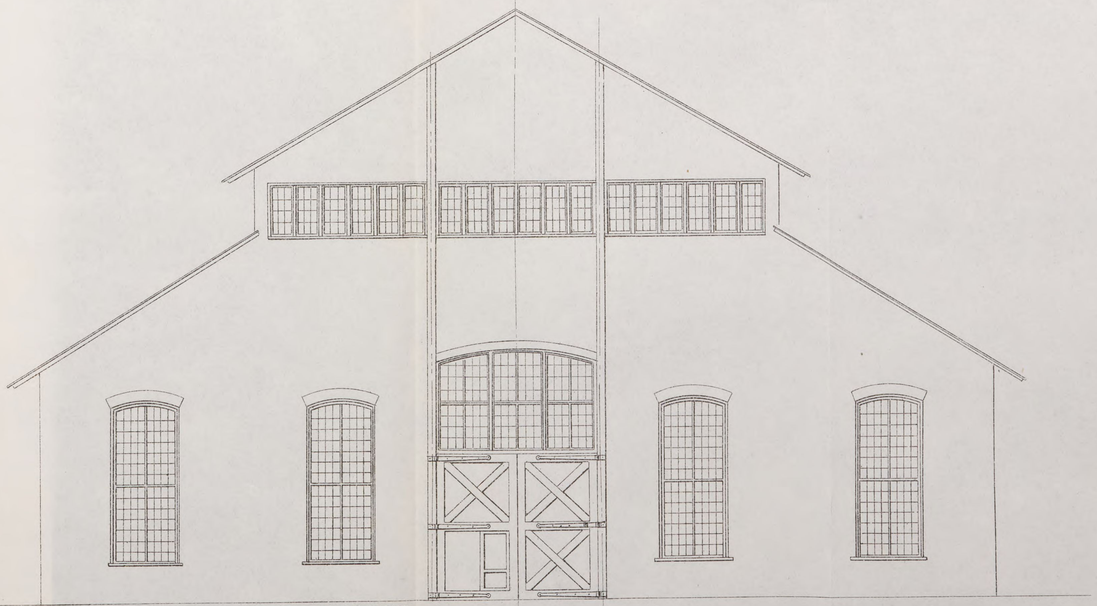
BENDING AND TEMPERING SHOP

SCALE $\frac{1}{8}$" = 2FT

14

APPENDIX A.





U. S. NAVY DEPARTMENT.
Armor Factory Board.
Nov 24, 1897.
W. Swift Chambers,
LIEUT. & RECORDER.

APPENDIX A.

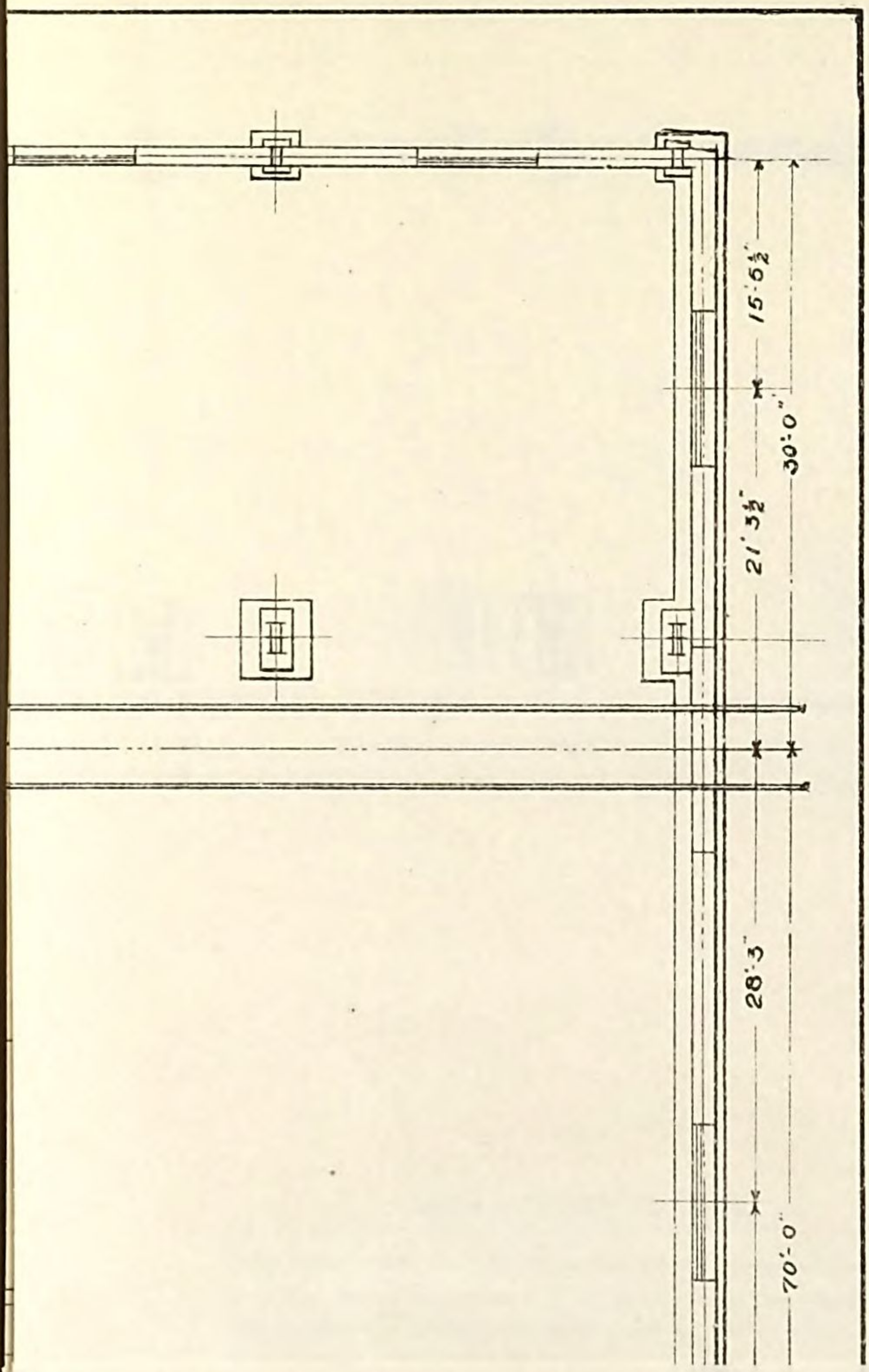
U.S. ARMOR PLATE FACTORY

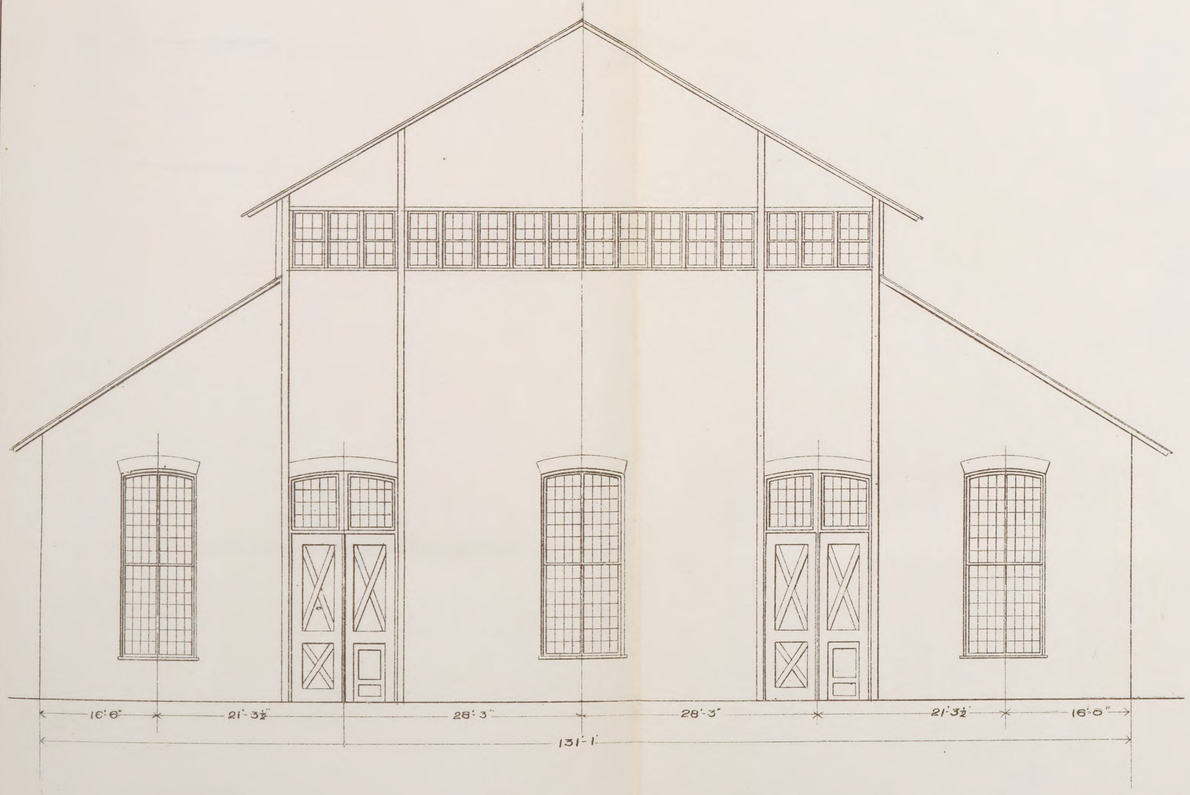
AS PROPOSED

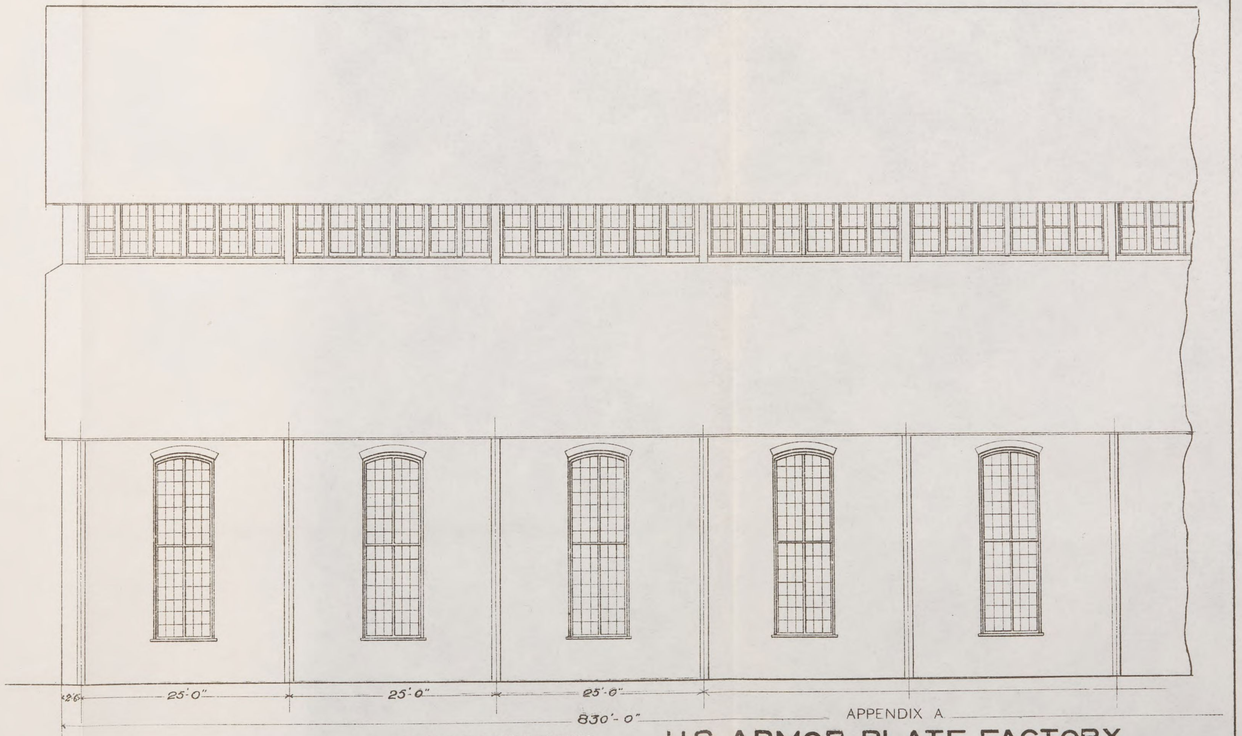
BENDING AND TEMPERING SHOP

SCALE $\frac{1}{8}$ 2FT

15


15'-6½"
21'-3½"
30'-0"
28'-3"
70'-0"





APPENDIX A

U. S. NAVY DEPARTMENT.
Armor Factory Board.
Nov. 24, 1897.
W. Swing Chambers,
LIEUT. & RECORDER.

U.S. ARMOR PLATE FACTORY

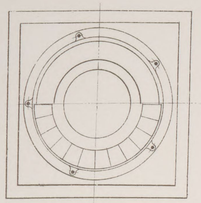
AS PROPOSED

MACHINE SHOP

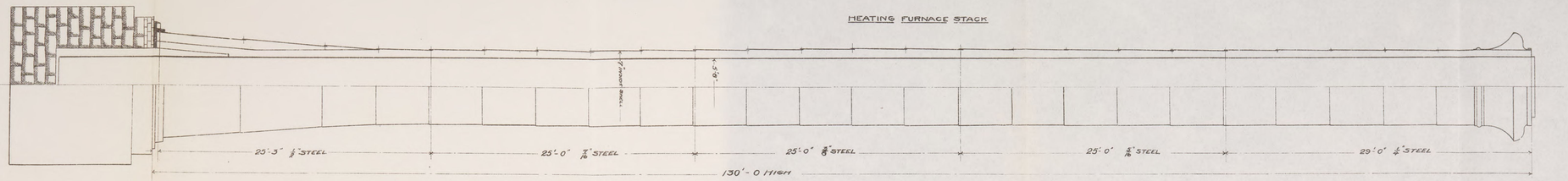
SCALE ⅛-1FT

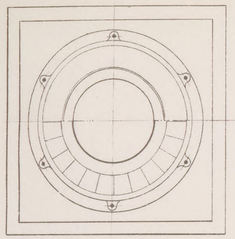
17

H Doc. 95—55 2



HEATING FURNACE STACK





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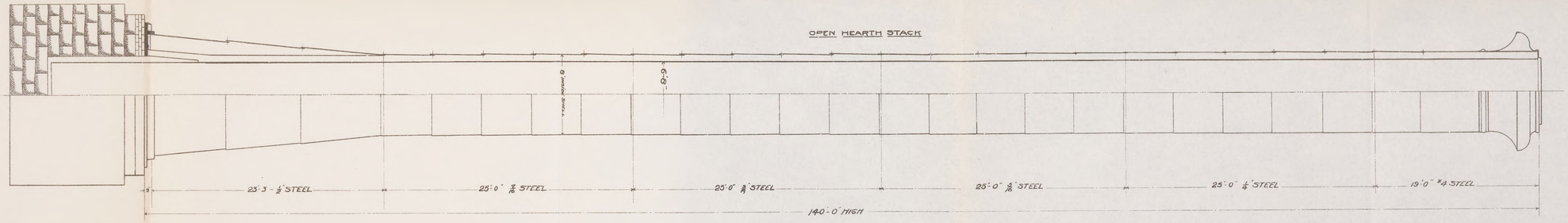
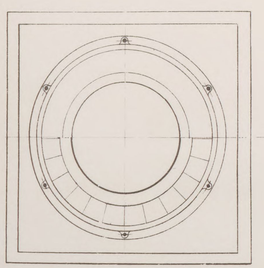
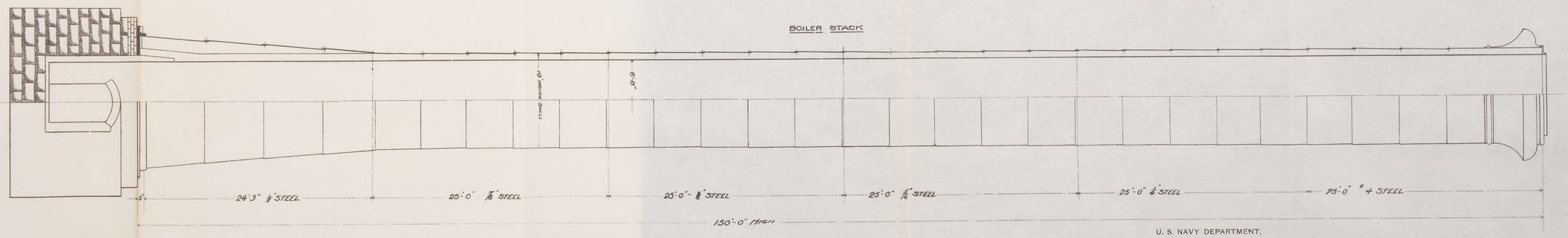




BOILER STACK



U. S. NAVY DEPARTMENT,
Armor Factory Board.
NOV 24, 1897.
W. Swift Hamilton
LIEUT. & RECORDER.

U.S. ARMOR PLATE FACTORY

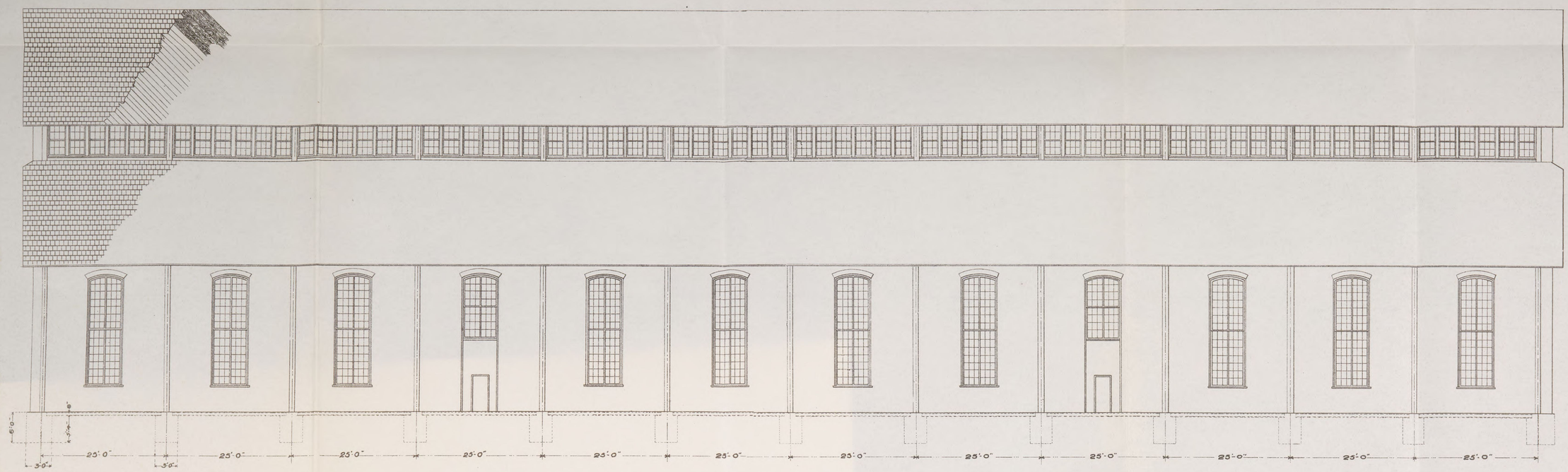
AS PROPOSED

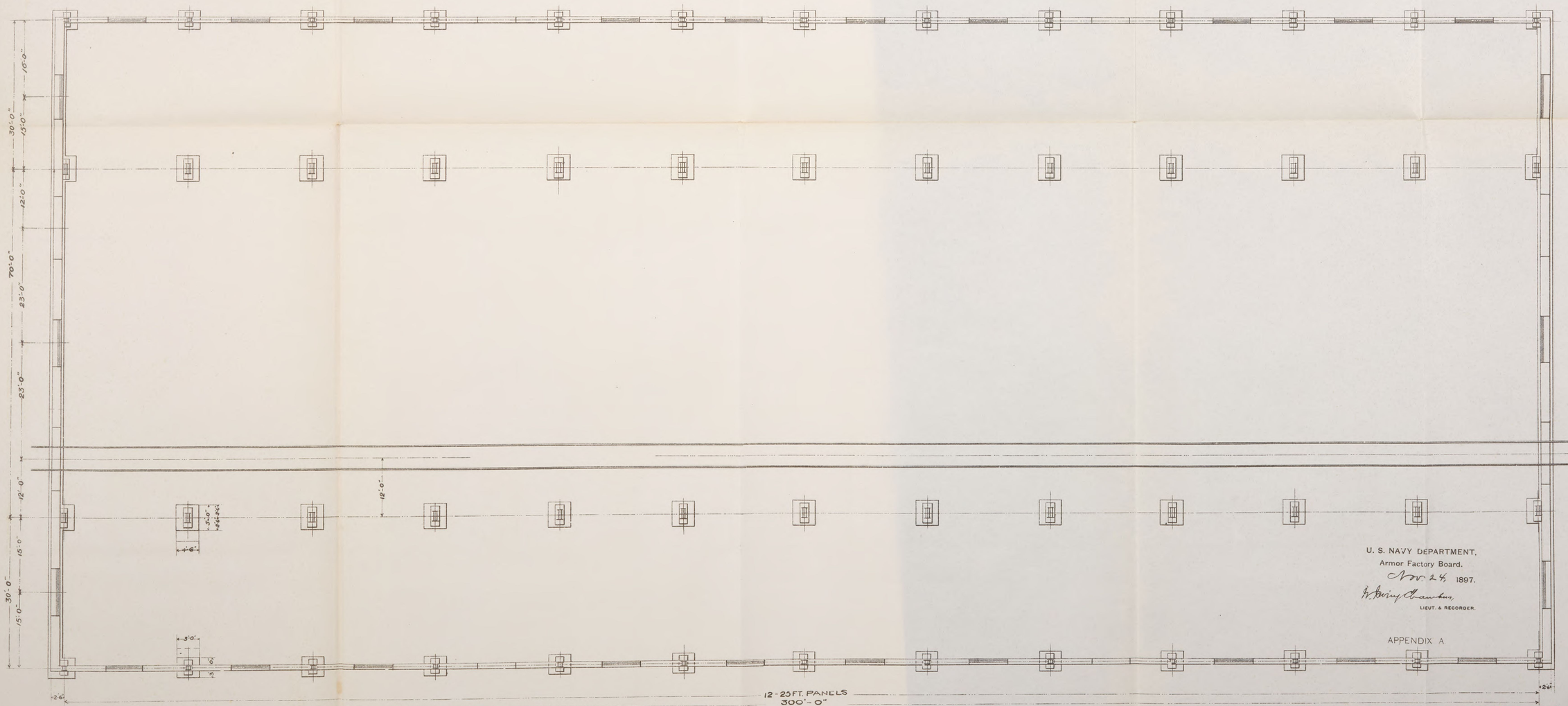
STACKS

SCALE ¼" = 2FT

APPENDIX A

18





U. S. NAVY DEPARTMENT,
Armor Factory Board.
Nov. 24, 1897.
B. Irving Chambers,
LIEUT. & RECORDER.

APPENDIX A.

U.S. ARMOR PLATE FACTORY

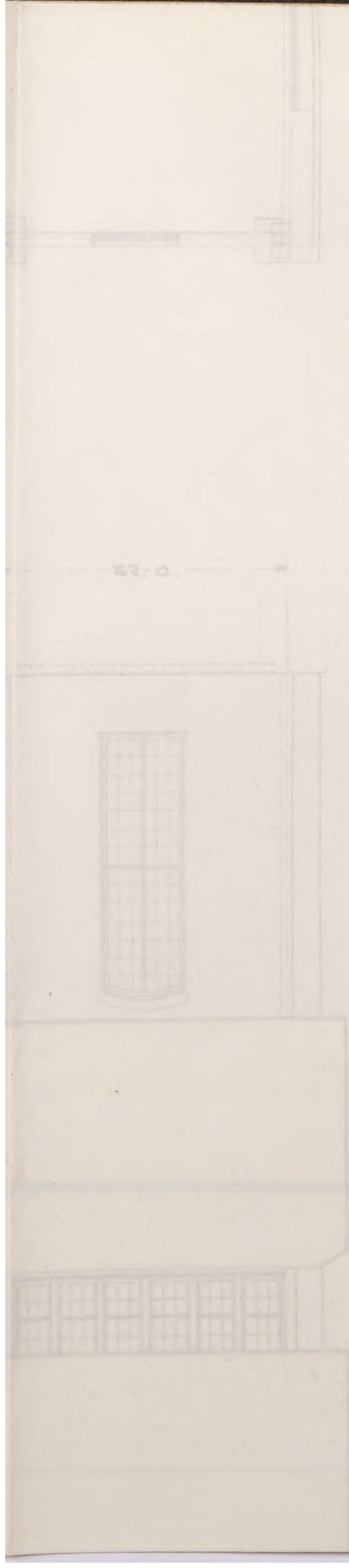
AS PROPOSED

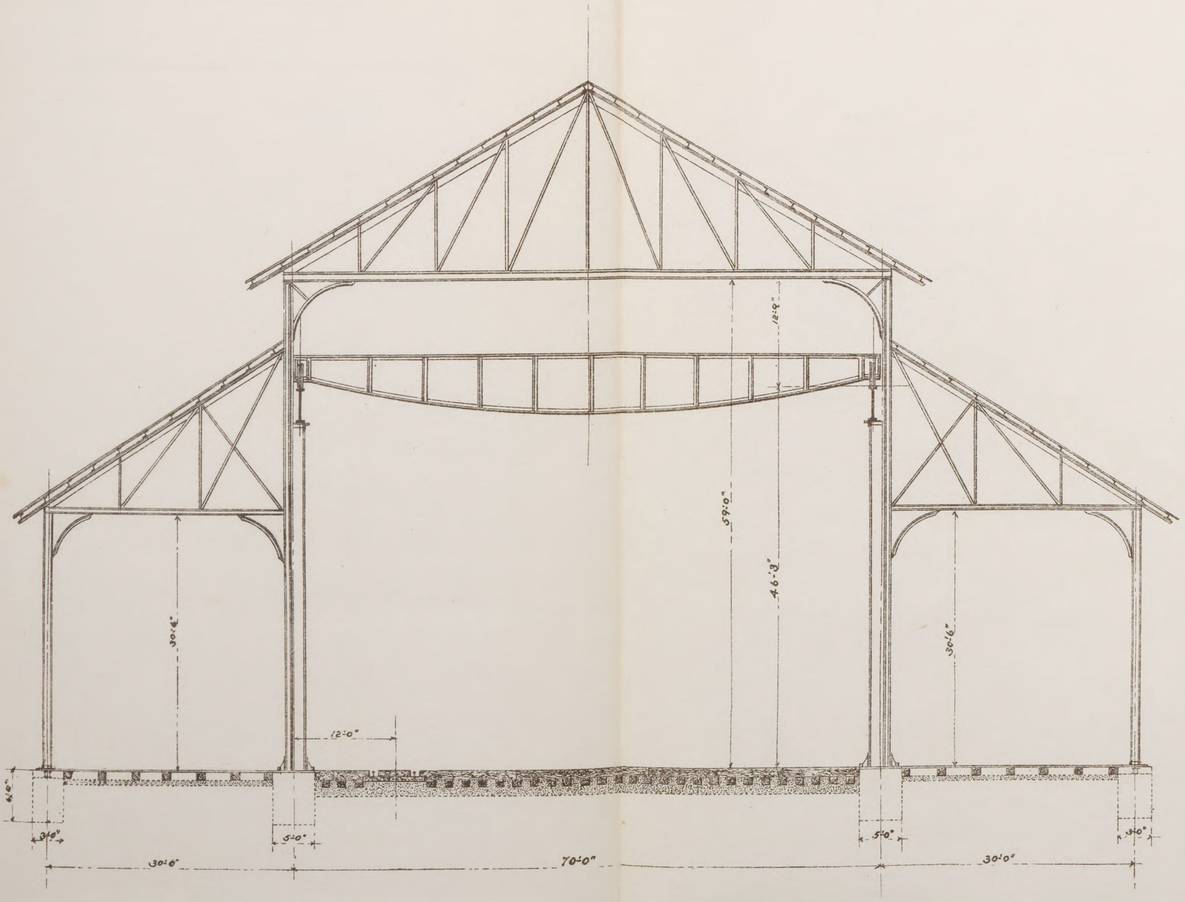
ERECTING SHOP

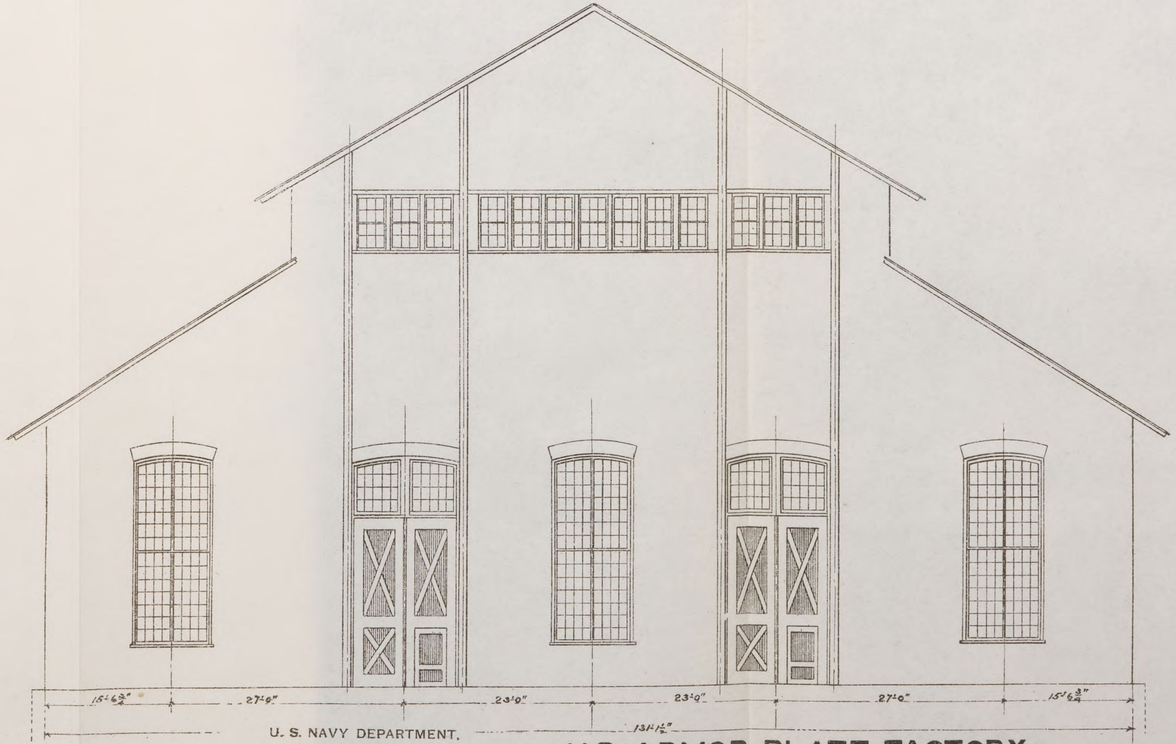
SCALE 1/8-2FT

19

H Doc. 75.....55 2







U. S. NAVY DEPARTMENT.
Armor Factory Board.
Nov. 24. 1897.
W. Swing Chambers,
LIEUT. & RECORDER.

U.S. ARMOR PLATE FACTORY

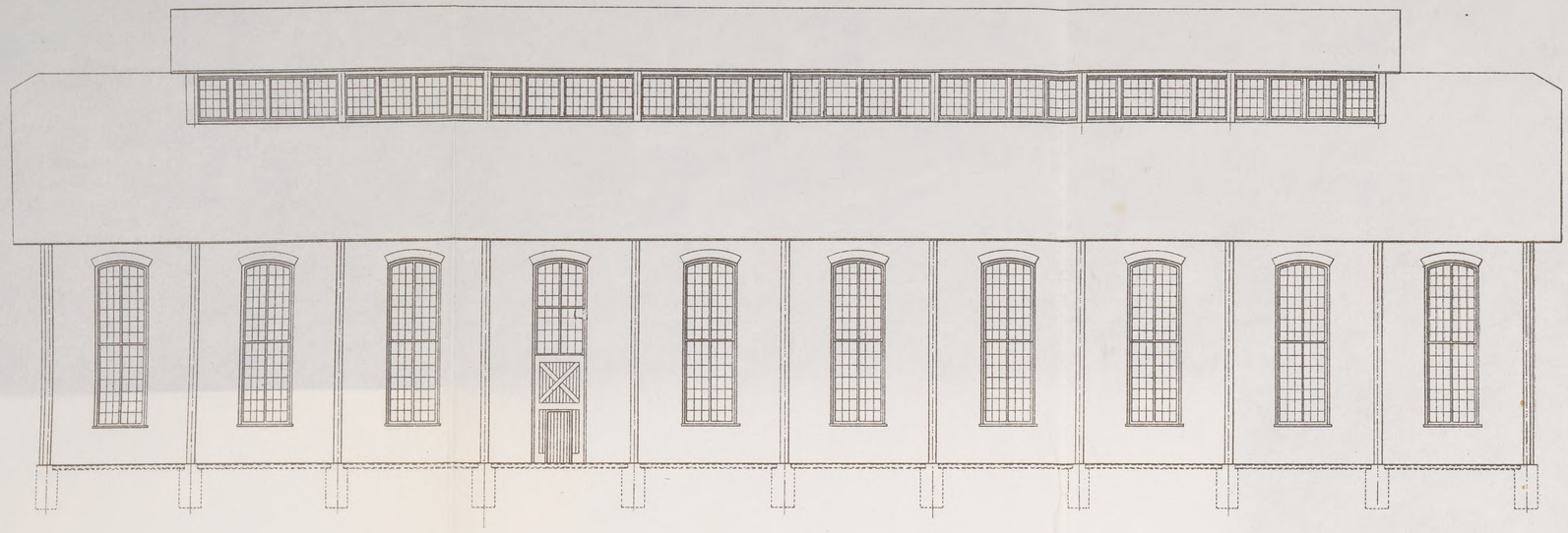
AS PROPOSED

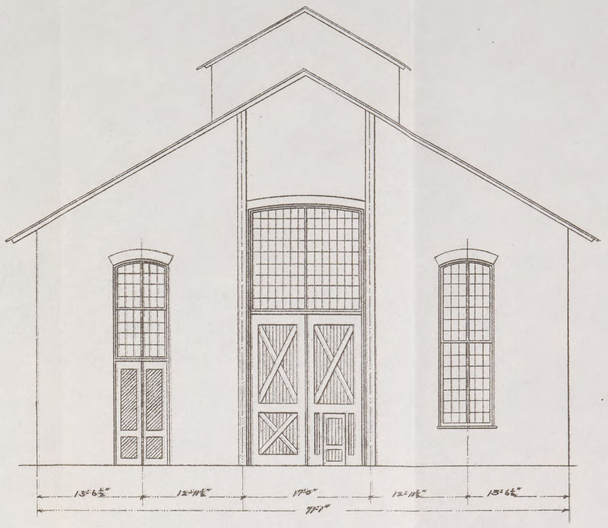
ERECTING SHOP

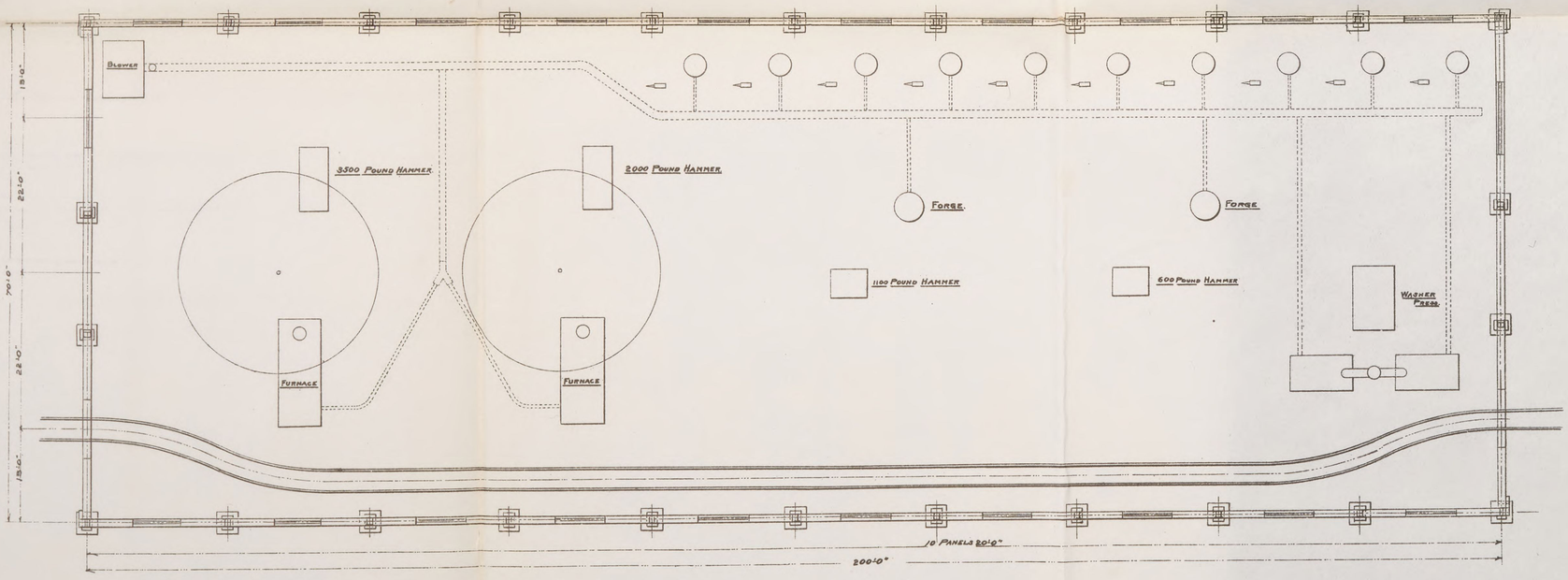
SCALE $\frac{1}{8}$ 2FT

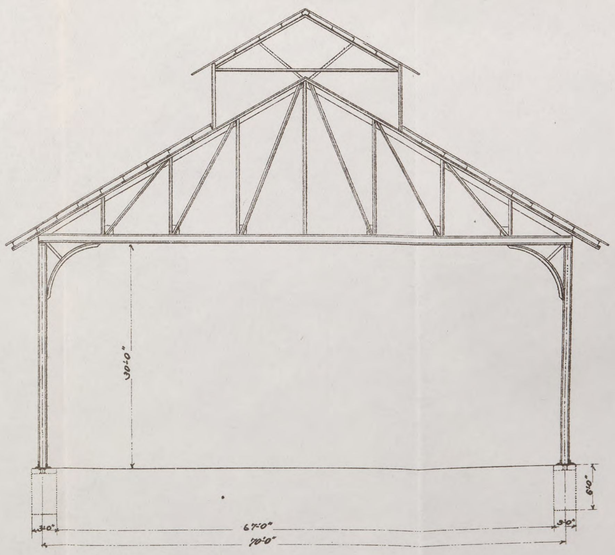
APPENDIX A **20**

H Doc 95....55 2









U. S. NAVY DEPARTMENT.
Armor Factory Board.
Nov. 24 1897.
W. Berry Chambers,
LIEUT. & RECORDER.

APPENDIX A.

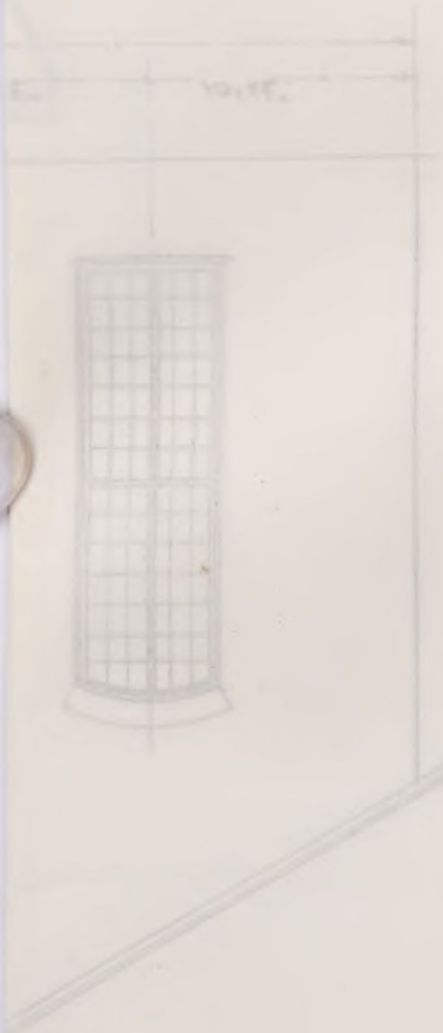
U.S. ARMOR PLATE FACTORY

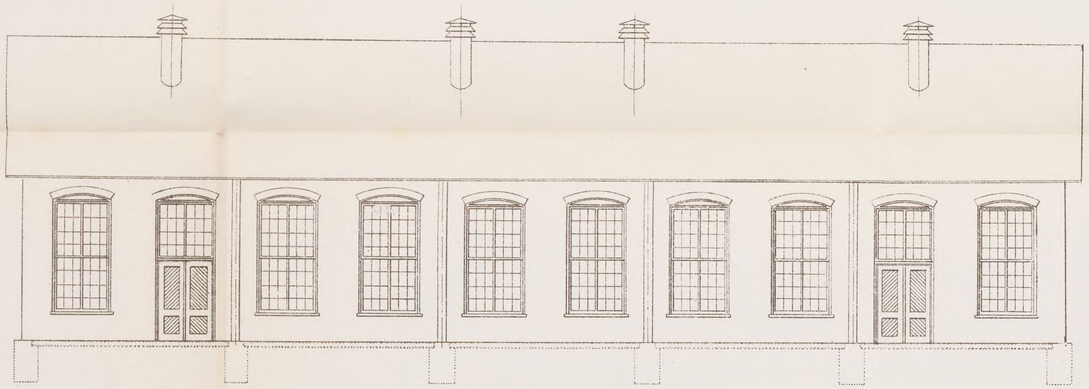
AS PROPOSED

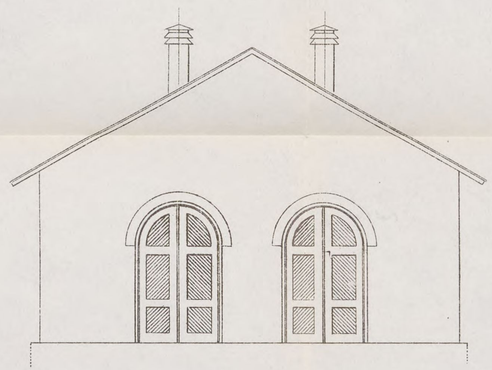
BLACKSMITH SHOP

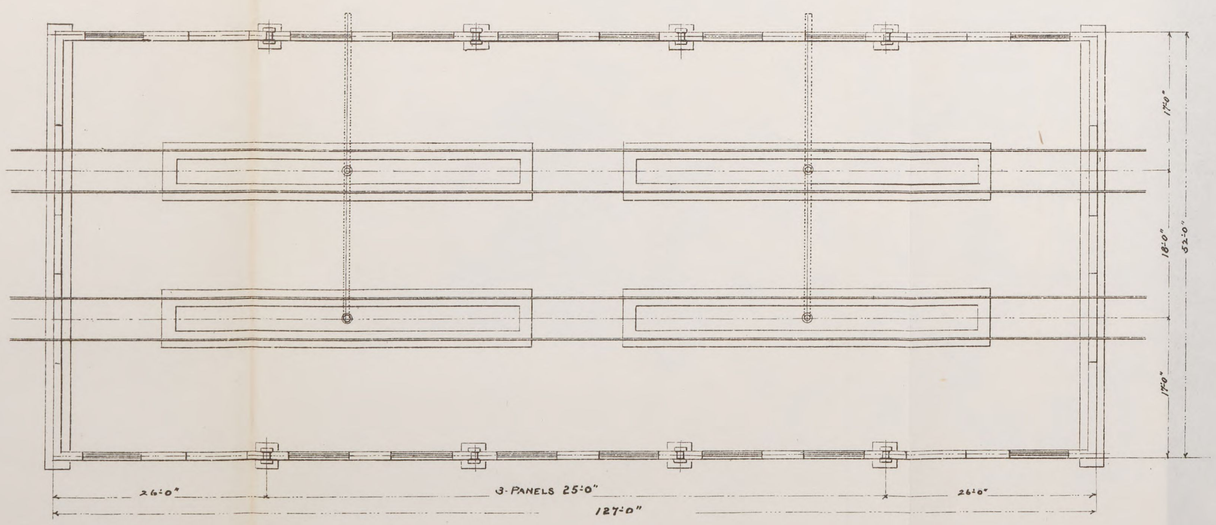
SCALE ⅛"-2FT

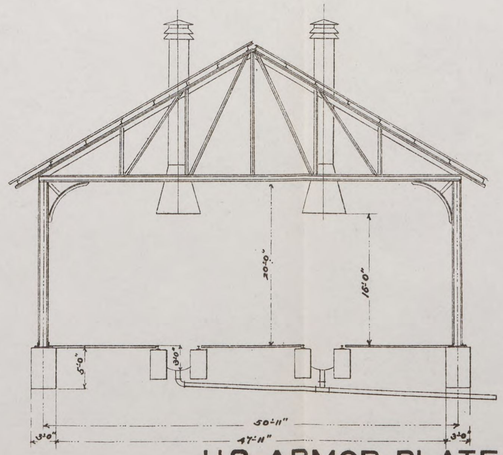
21











U. S. NAVY DEPARTMENT,
Armor Factory Board.
Nov. 24, 1897.
W. Berry Chambers,
LIEUT. & RECORDER.

APPENDIX A

U.S. ARMOR PLATE FACTORY

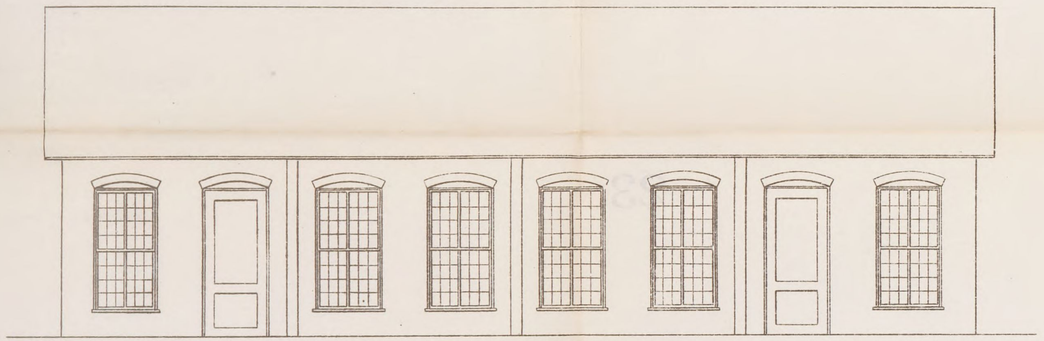
AS PROPOSED

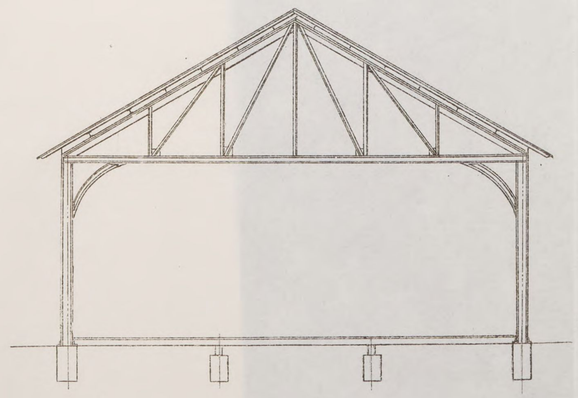
LOCOMOTIVE HOUSE

SCALE $\frac{1}{8}$2FT

22

22





U. S. NAVY DEPARTMENT.
Armor Factory Board.
Nov 24 1897.
W. Irving Chambers,
LIEUT. & RECORDER.

APPENDIX A.

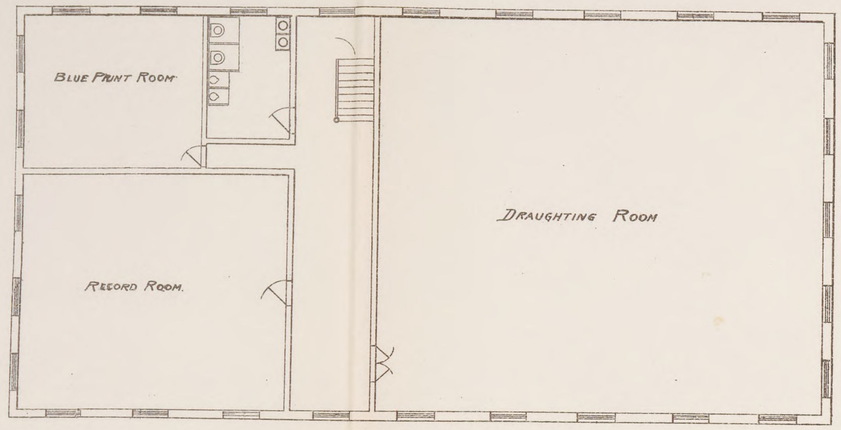
U.S. ARMOR PLATE FACTORY

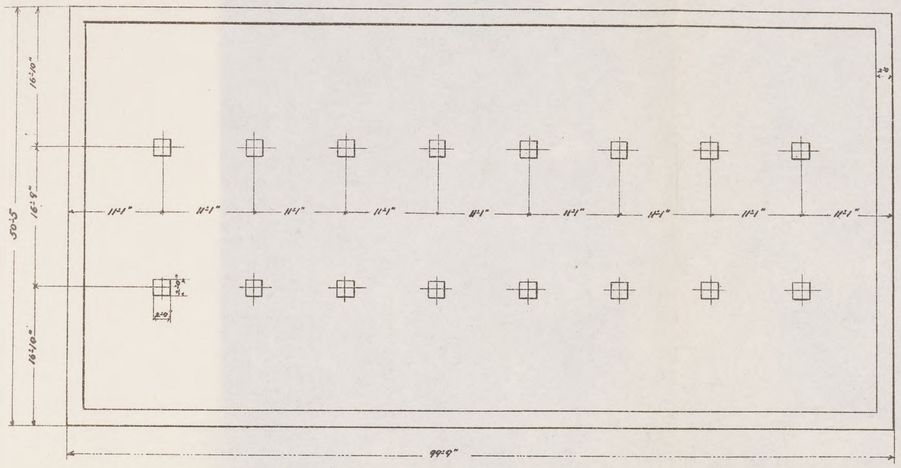
AS PROPOSED

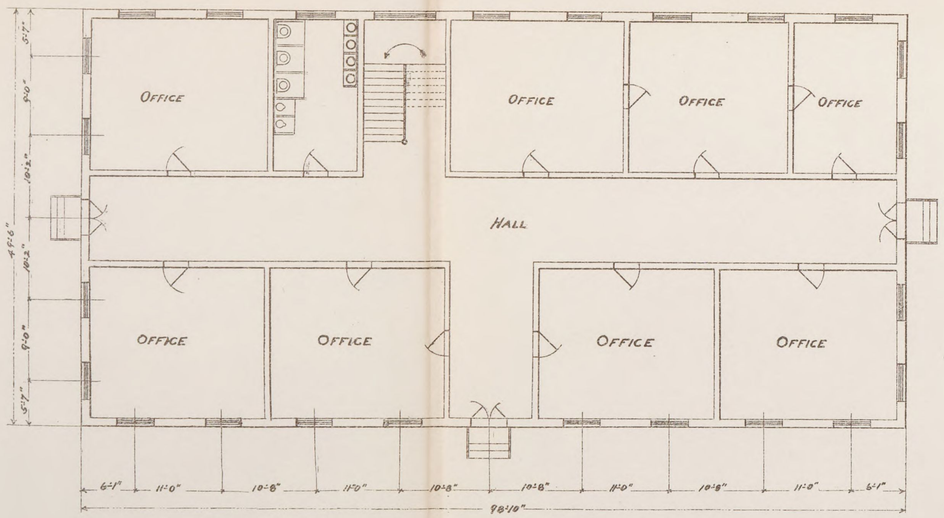
CARPENTER SHOP

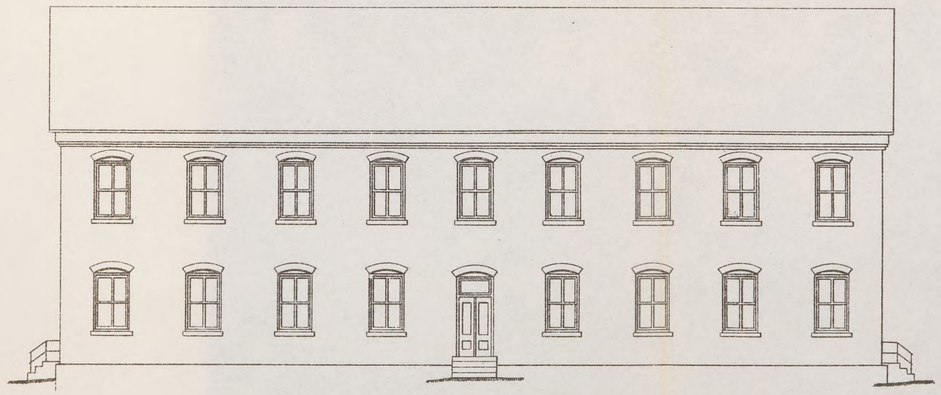
SCALE $\frac{1}{8}$-2FT

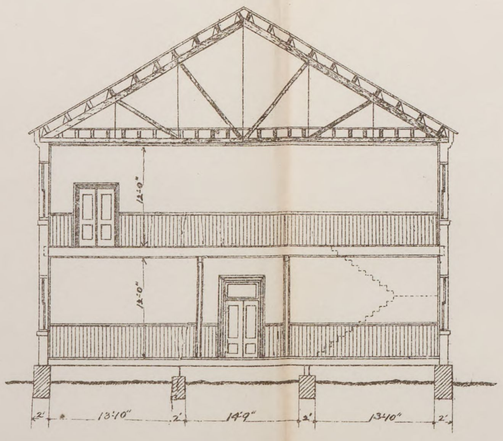
23











U. S. NAVY DEPARTMENT,
Armor Factory Board.
Nov. 24, 1897.
W. Berry Chambers,
LIEUT. & RECORDER.

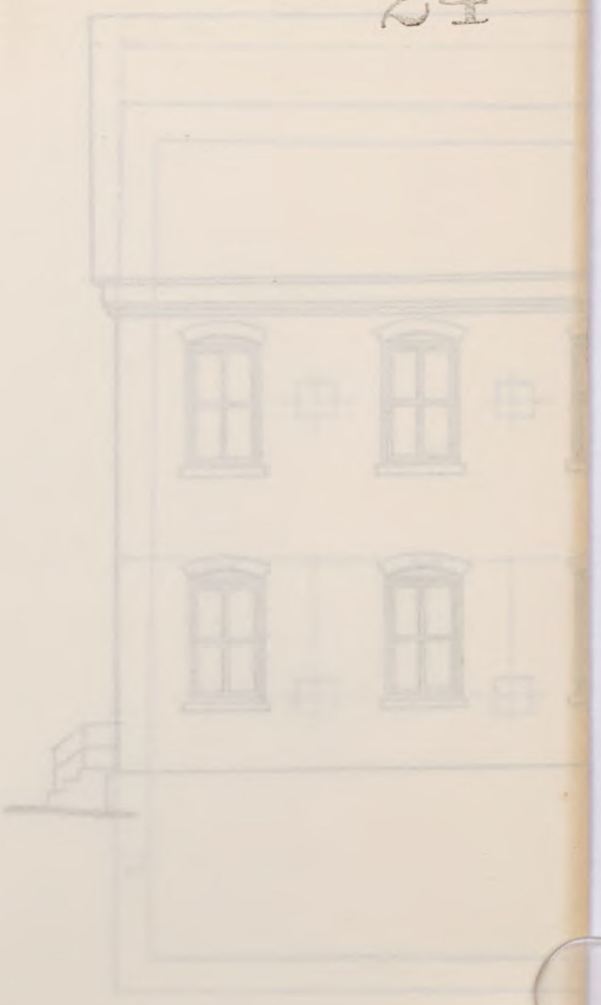
APPENDIX A.

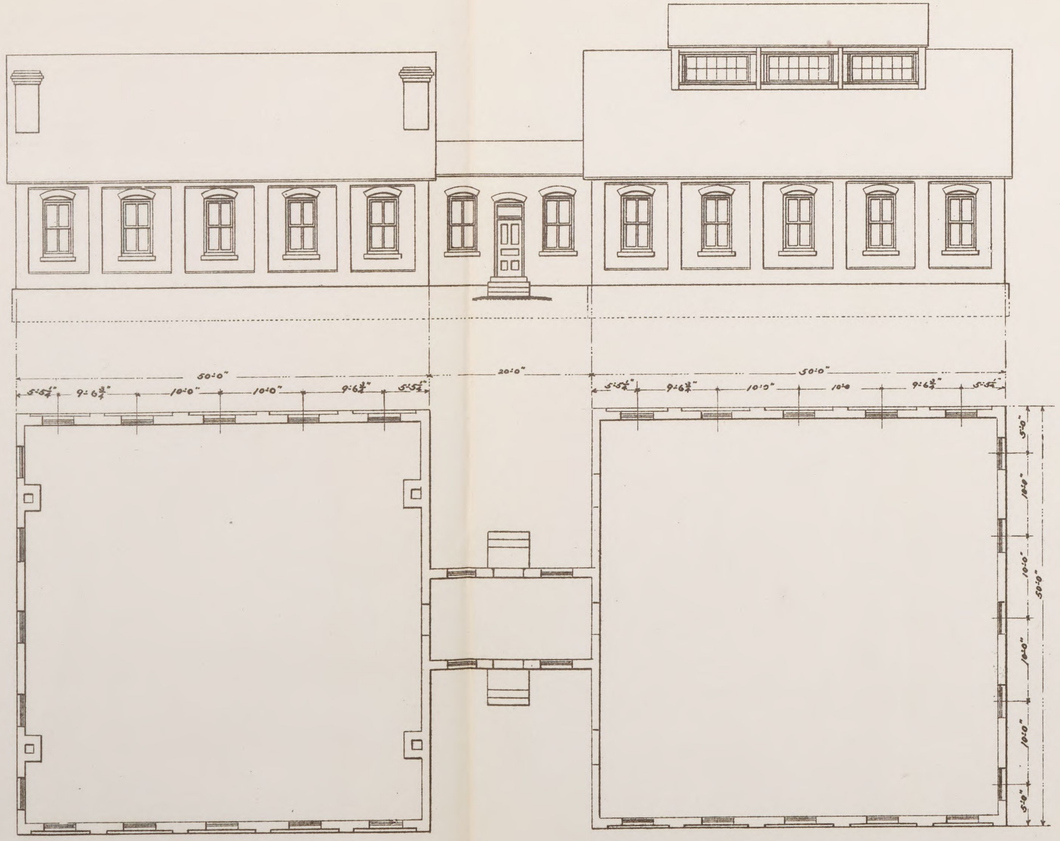
U.S. ARMOR PLATE FACTORY

AS PROPOSED

OFFICE

SCALE $\frac{1}{8}$"=2FT.



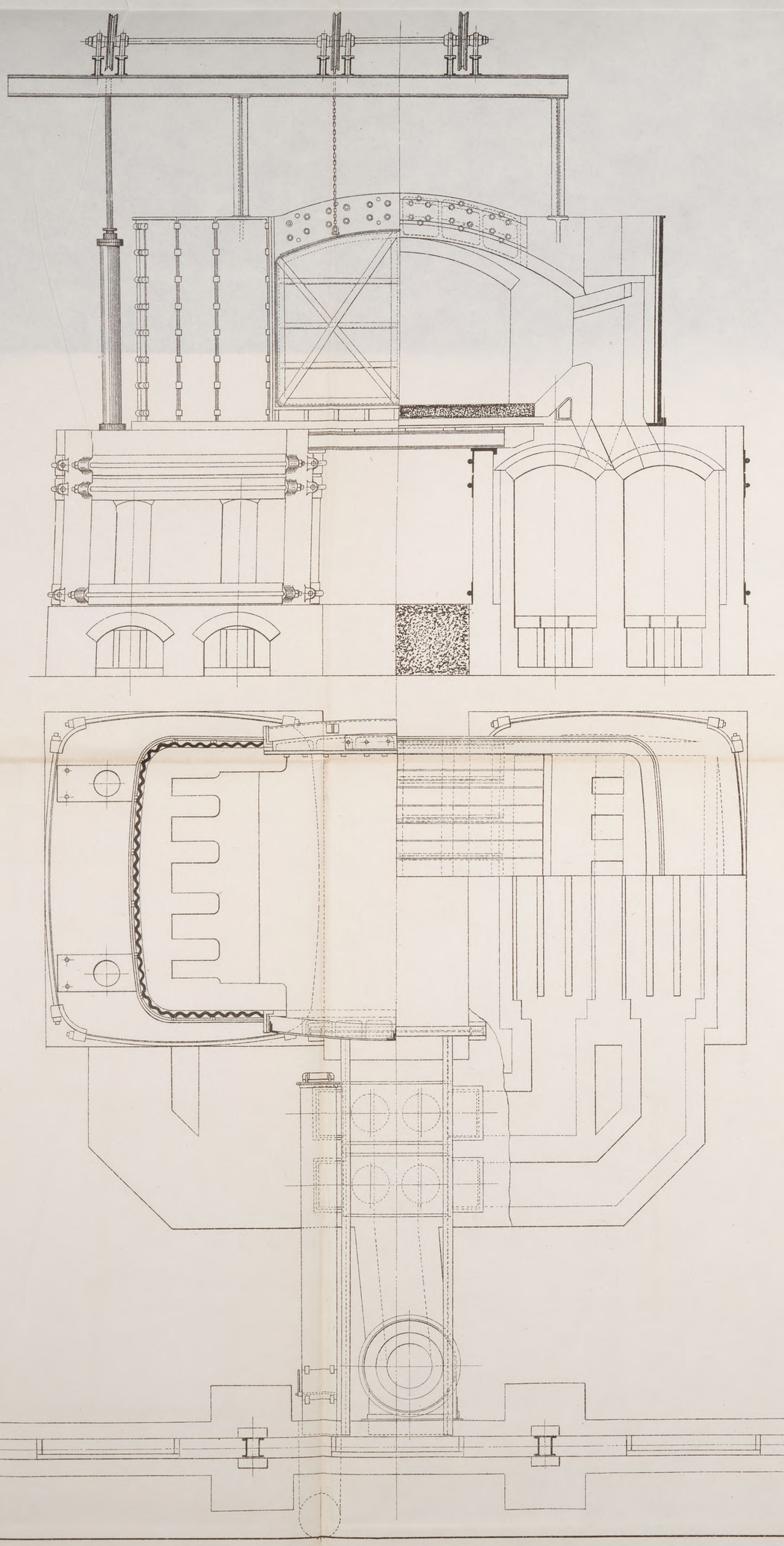

50'0"
20'0"
50'0"
10'0"
10'0"
10

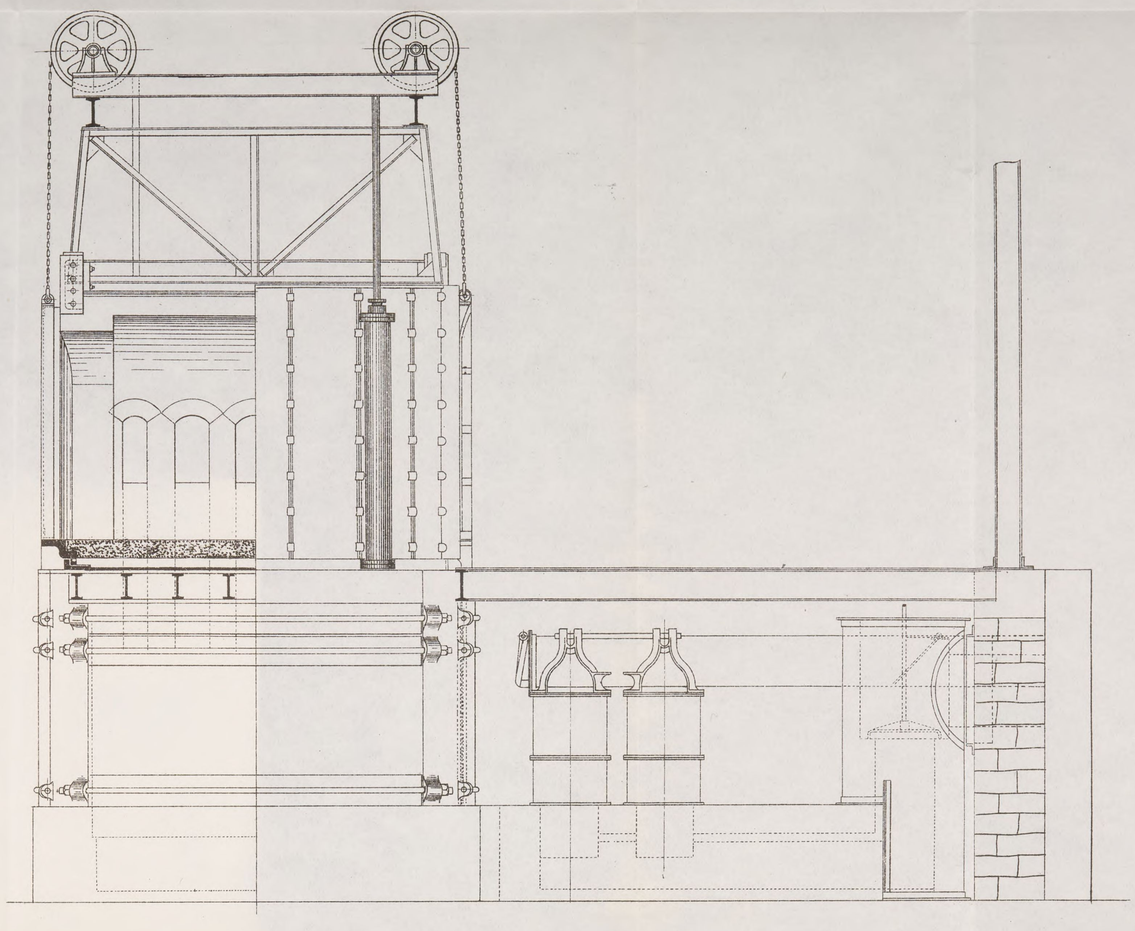
U. S. NAVY DEPARTMENT.
Armor Factory Board.
Nov 24, 1897.
B. Darling Chamberlain,
LIEUT. & RECORDER.

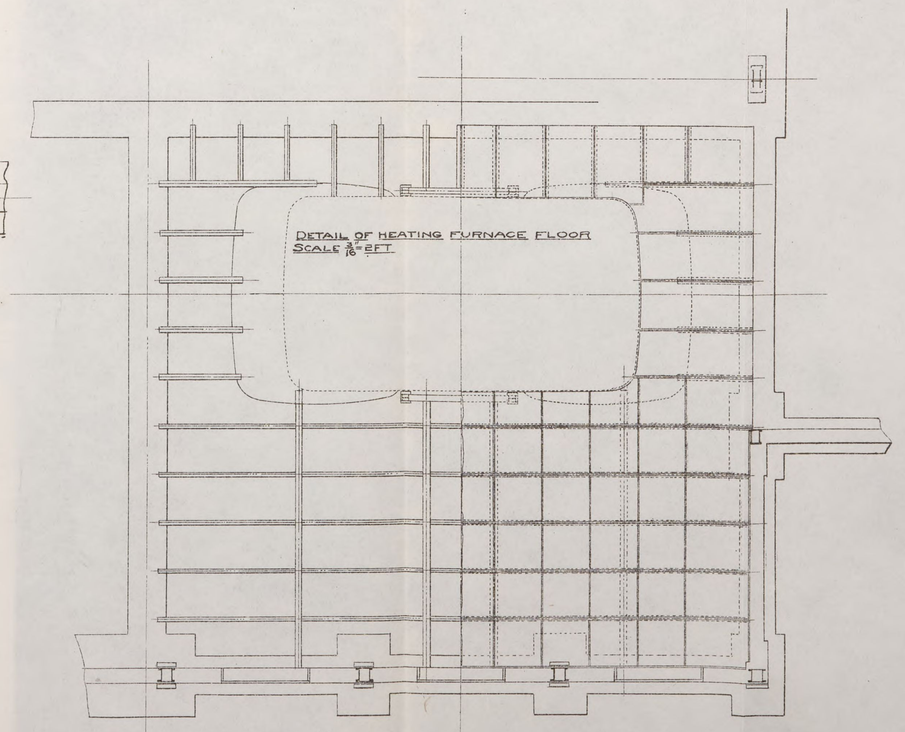
APPENDIX A.

U.S. ARMOR PLATE FACTORY

AS PROPOSED







HEATING FURNACE 26

SCALE 3/8=1FT

U. S. NAVY DEPARTMENT,
Armor Factory Board.
Nov. 24 1897.
W. Berry Saunders,
LIEUT. & RECORDER.

APPENDIX A.

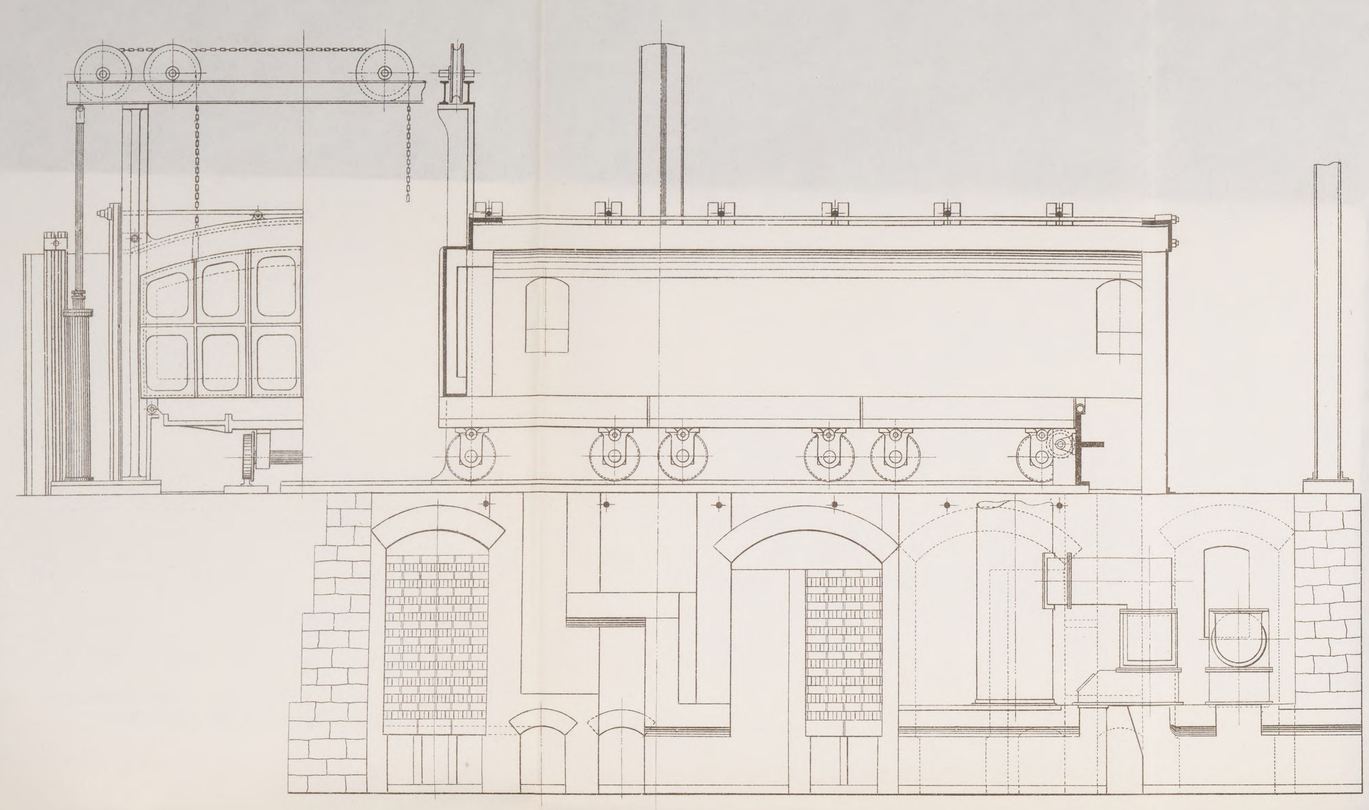
U.S. ARMOR PLATE FACTORY

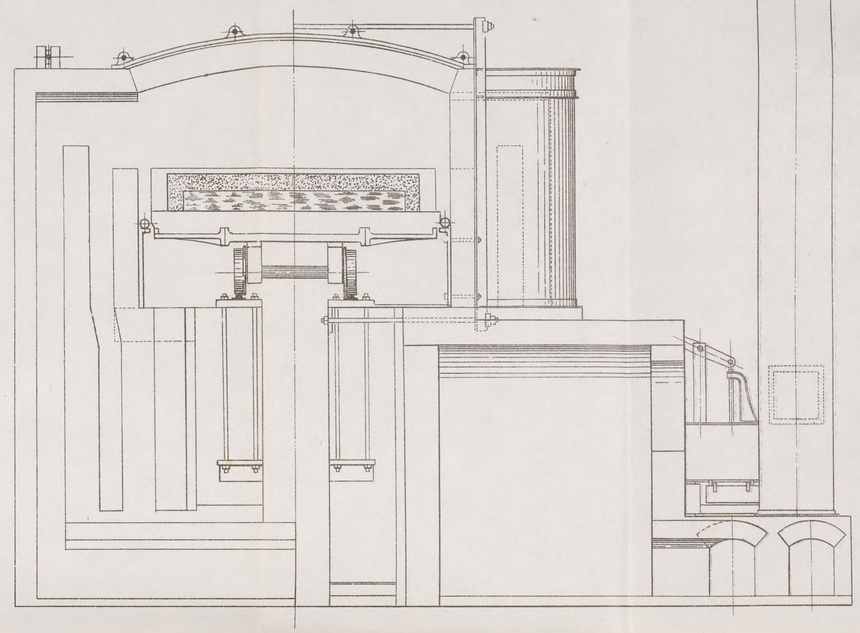
AS PROPOSED

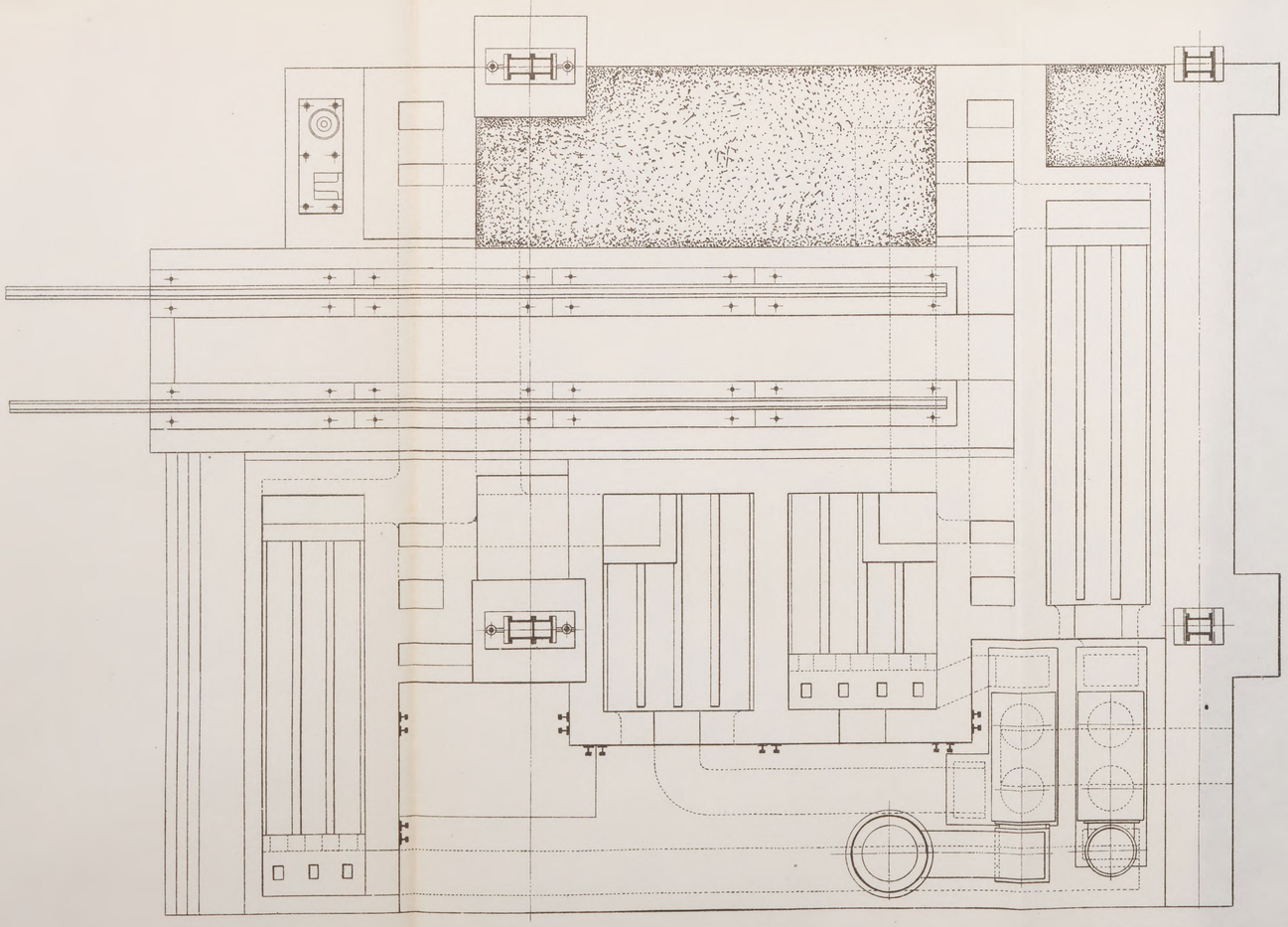
14'×22' CAR BOTTOM FURNACE

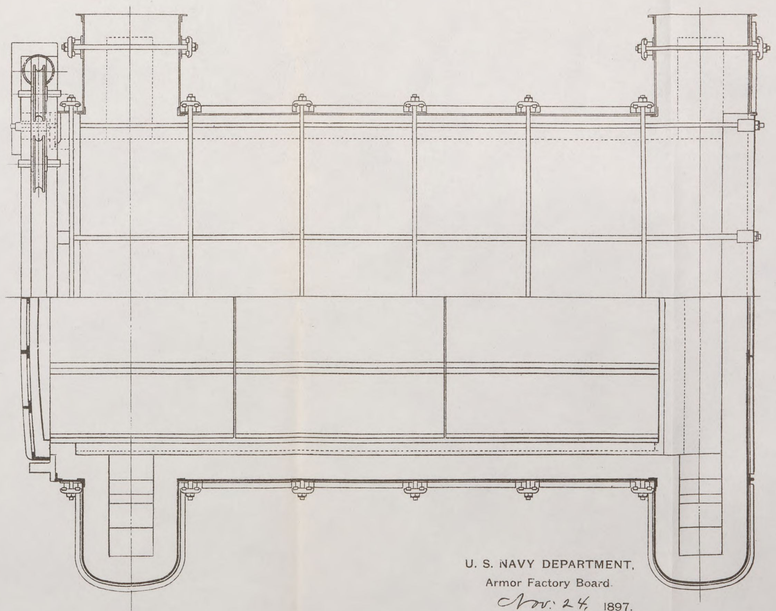
SCALE 3/8" = 1 FT

H Doc. 95 55 2









U. S. NAVY DEPARTMENT,
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Nov. 24. 1897.
W. Baring Brownson,
LIEUT. & RECORDER.

APPENDIX A.

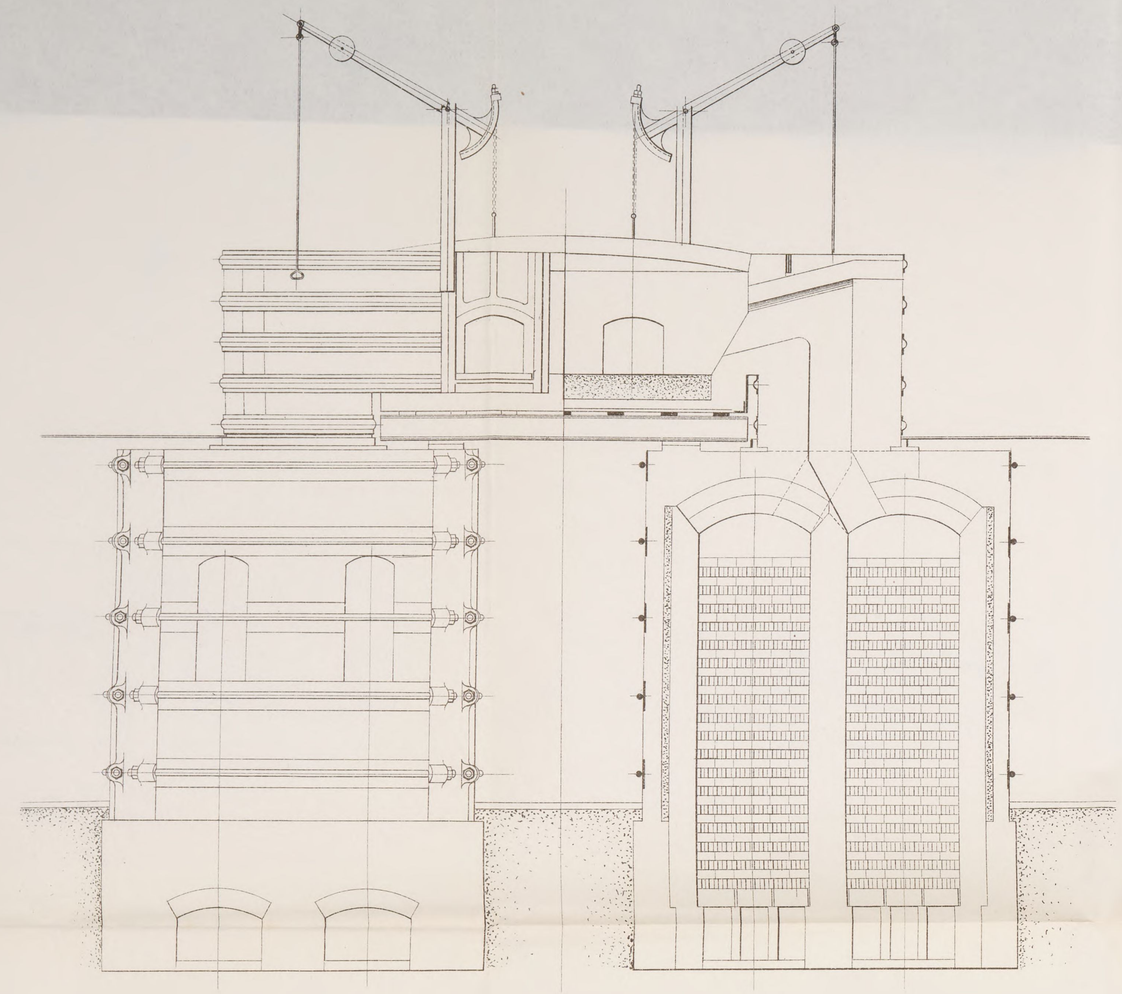
U.S. ARMOR PLATE FACTORY

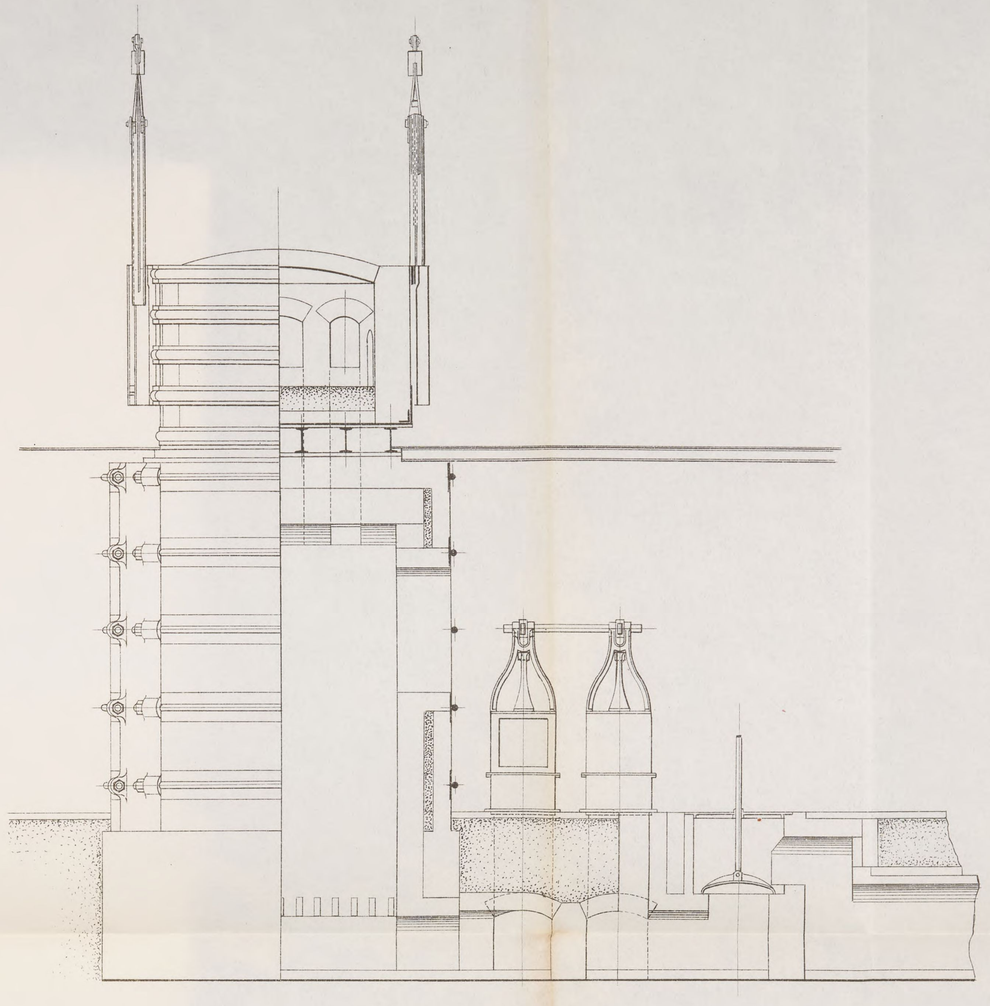
AS PROPOSED

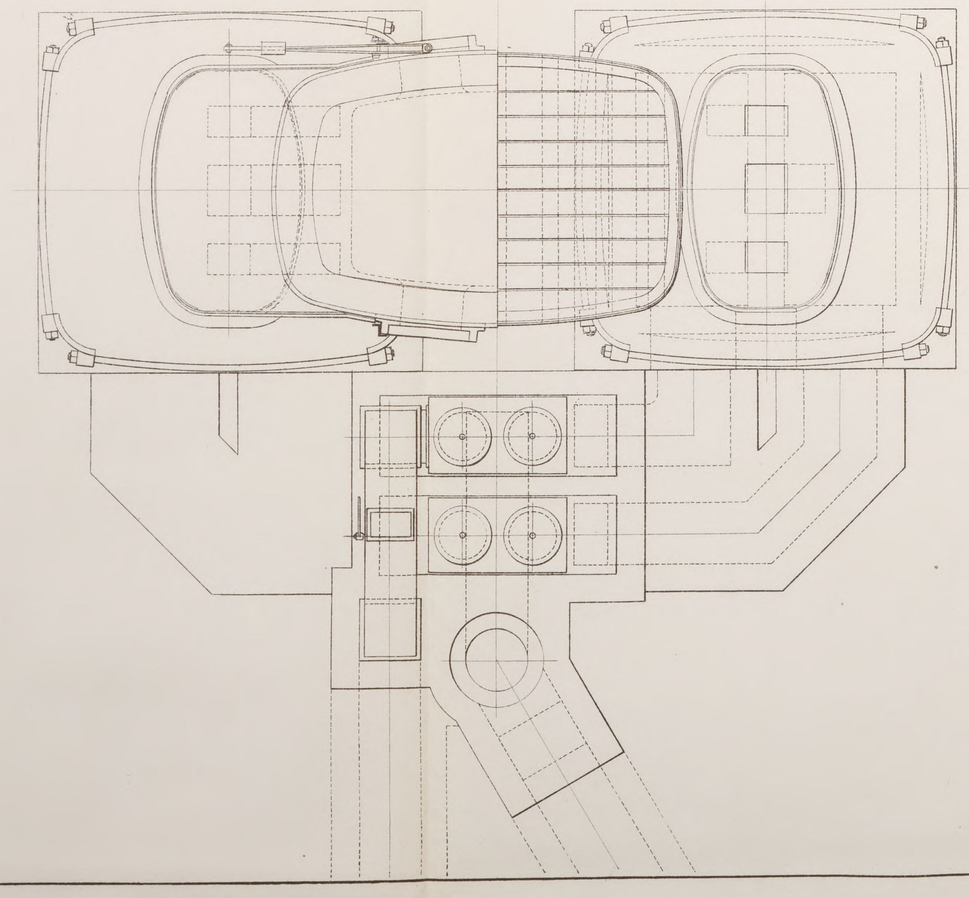
14'×30' CAR BOTTOM FURNACE

SCALE 1/8 2FT.

H Doc. 95 55 2







U. S. NAVY DEPARTMENT,
Armor Factory Board.
Nov. 24, 1897.
W. Berry Chambers,
LIEUT. & RECORDER.

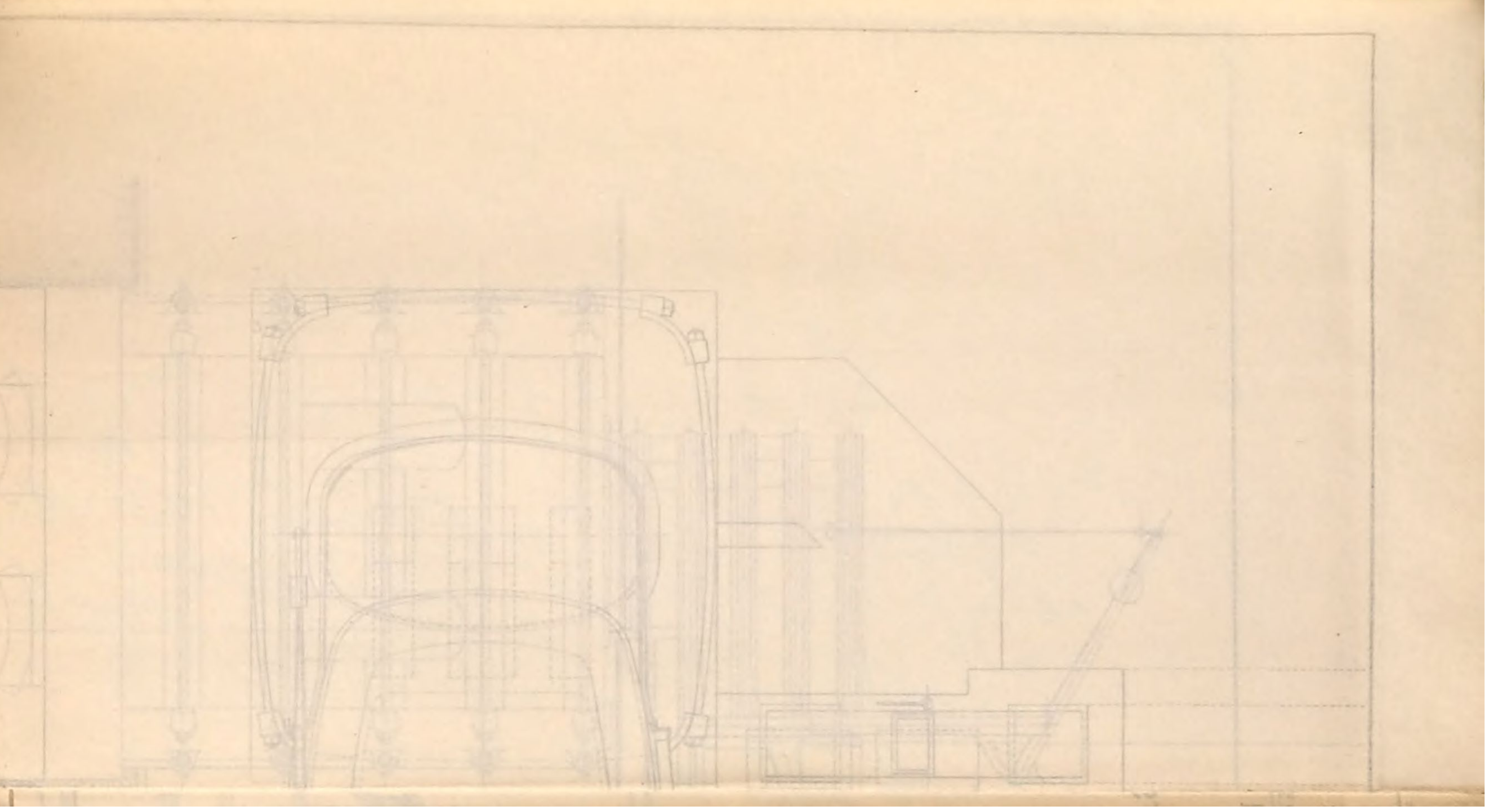
APPENDIX A

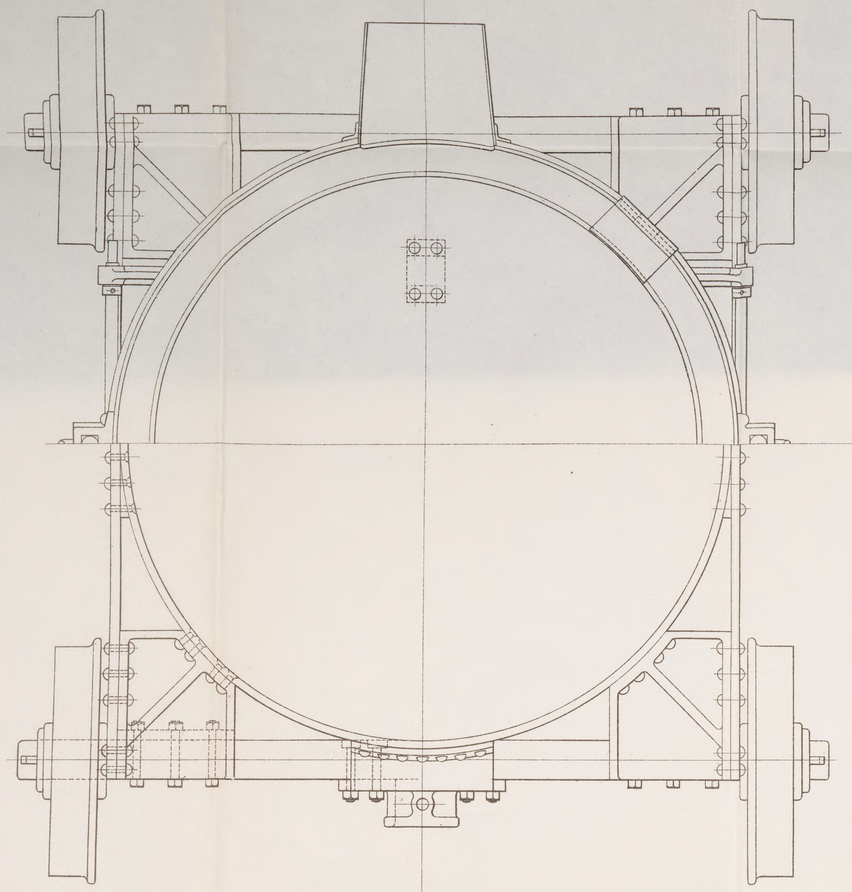
U.S. ARMOR PLATE FACTORY

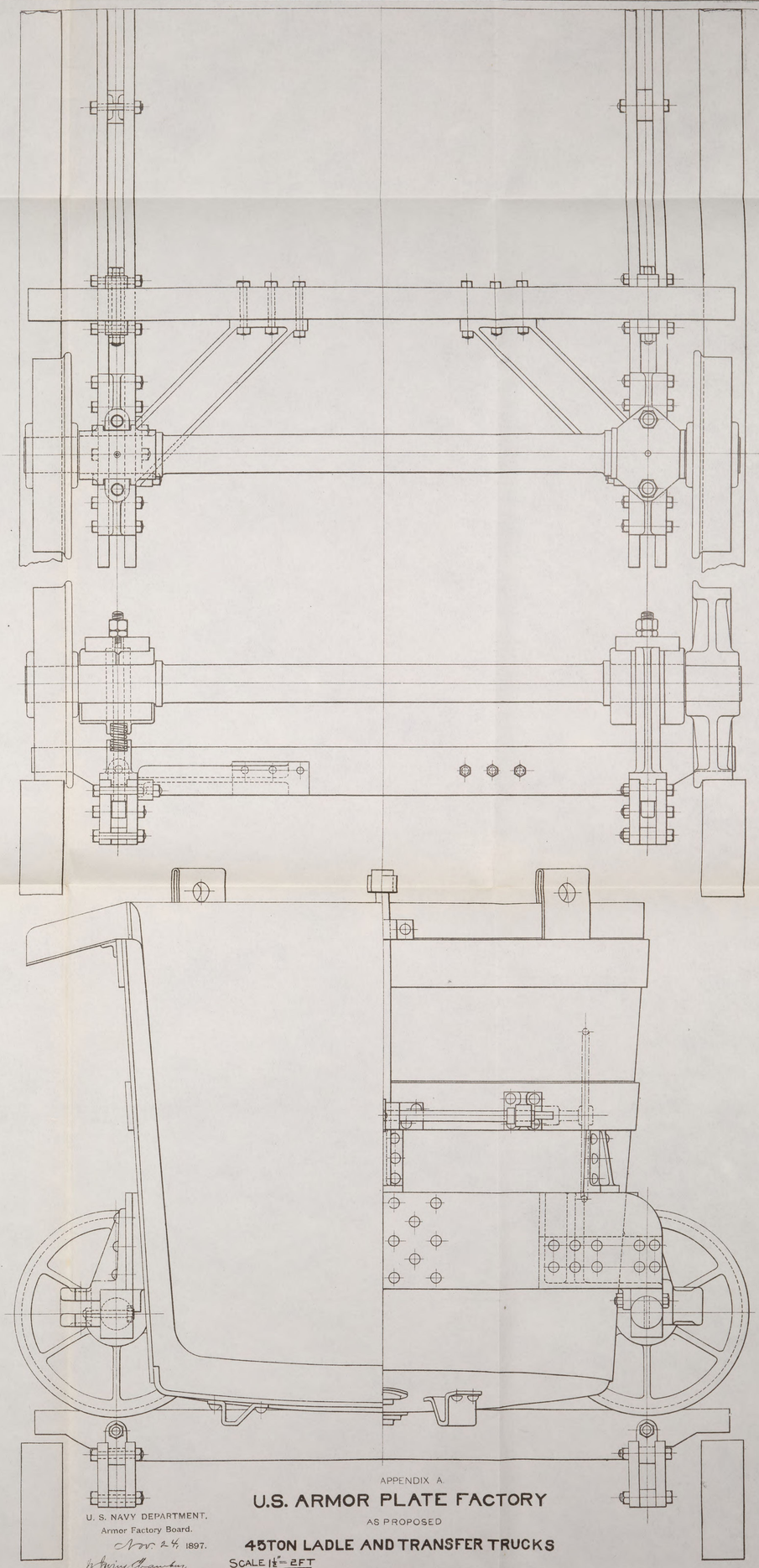
AS PROPOSED

PREHEATING FURNACE

SCALE 3/8" = 2 FT







APPENDIX A.

U.S. ARMOR PLATE FACTORY

AS PROPOSED

45TON LADLE AND TRANSFER TRUCKS

SCALE 1½"=2FT

U. S. NAVY DEPARTMENT.
Armor Factory Board.
Nov 24 1897.
W. Irving Chambers,
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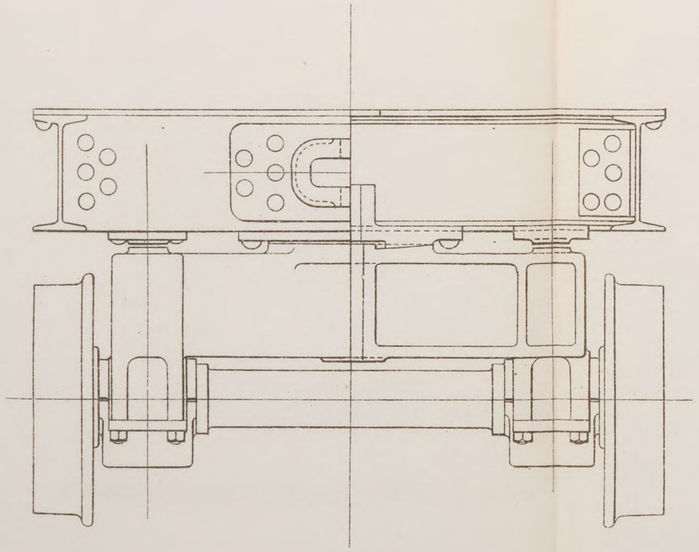
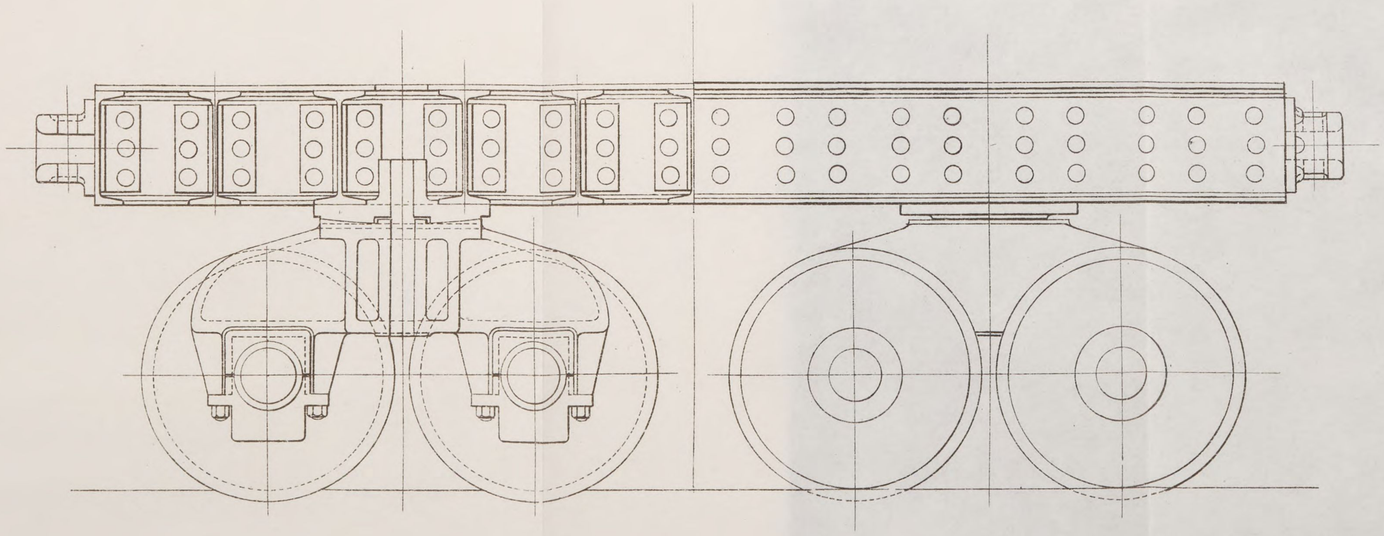
30





U. S. NAVY DEPARTMENT.
Armor Factory Board.
Nov 24, 1897.
W. Irving Chambers,
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APPENDIX A

U.S. ARMOR PLATE FACTORY

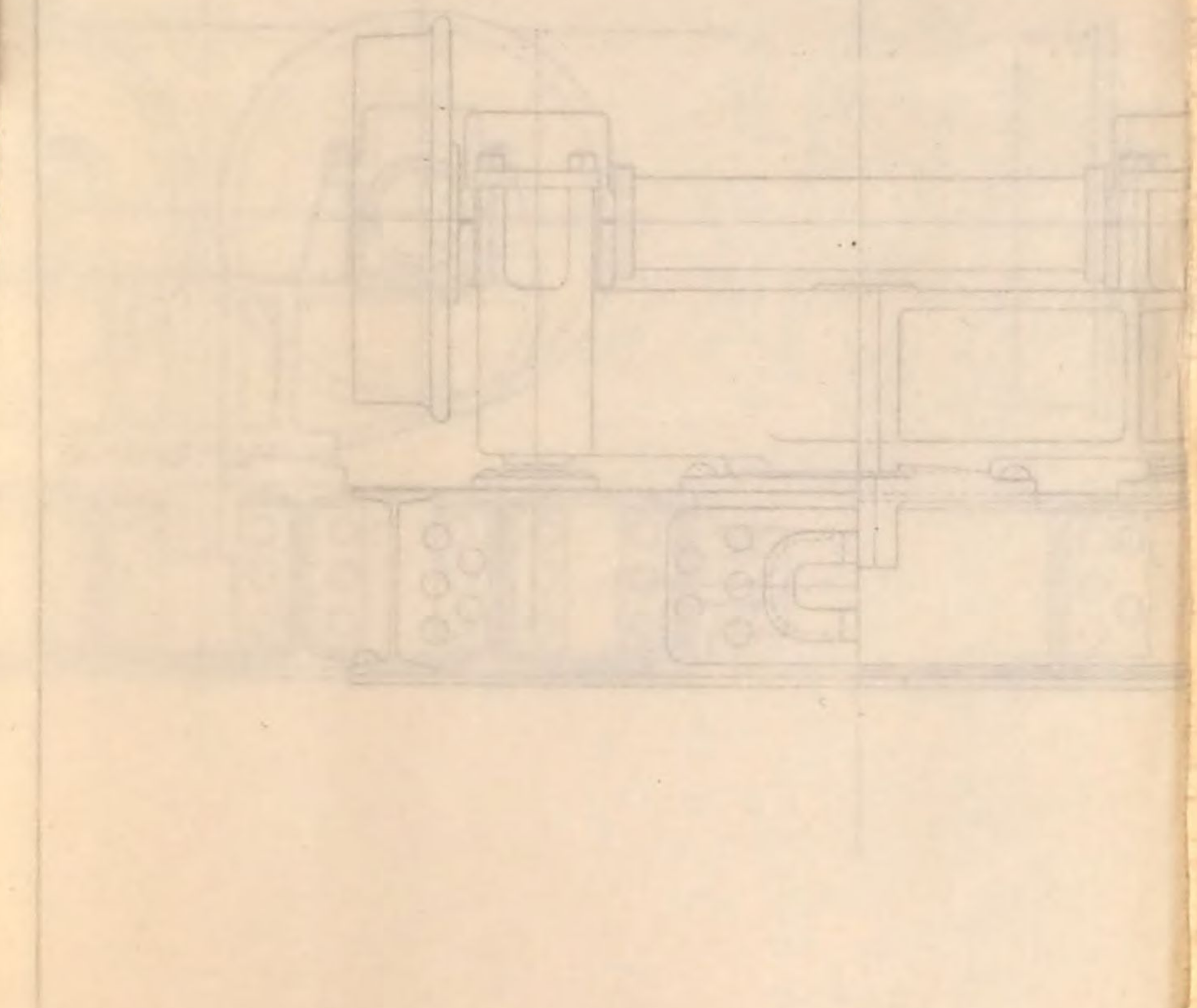
AS PROPOSED

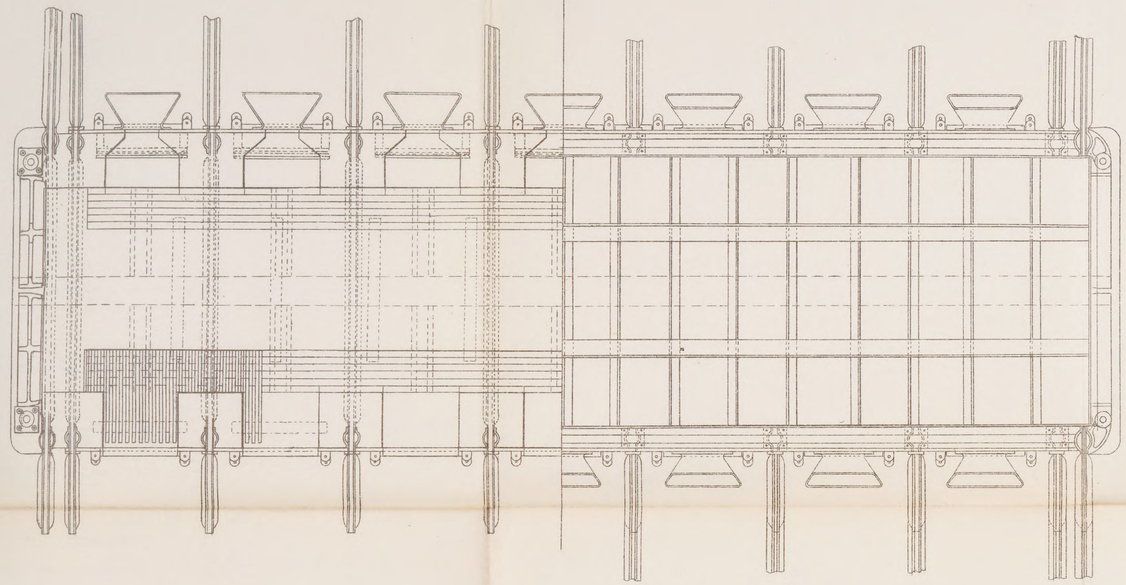
75 TON INGOT TRUCK

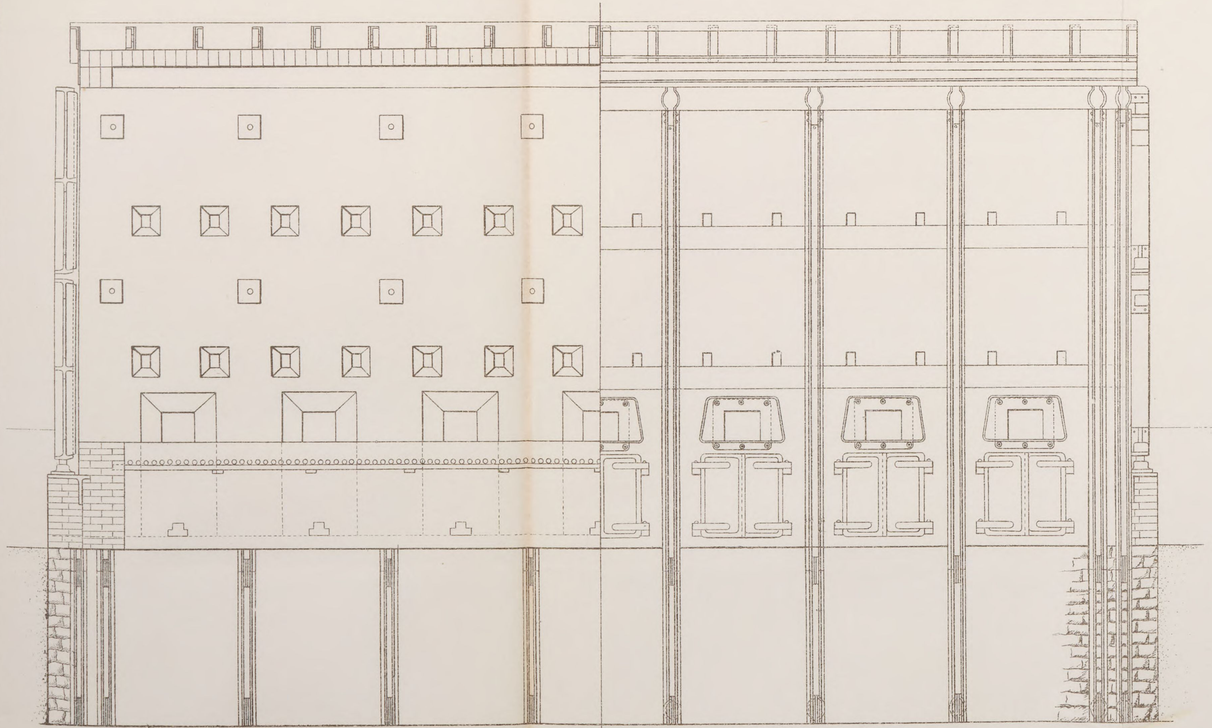
SCALE 1½-2 FT.

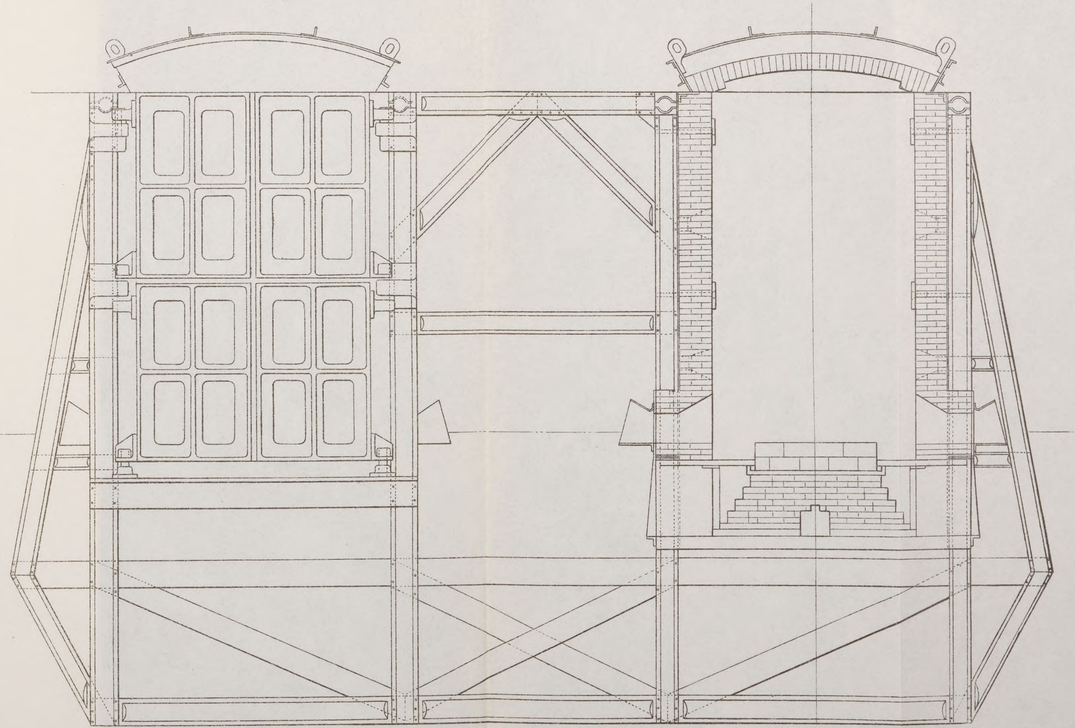
NOTE! TWO OF THESE MAKE UP THE 150 TON INGOT TRUCK.

H Doc. 95 55 2









U. S. NAVY DEPARTMENT,
Armor Factory Board.
Nov. 24, 1897.
W. Berry Chambers,
LIEUT. & RECORDER.

APPENDIX A.

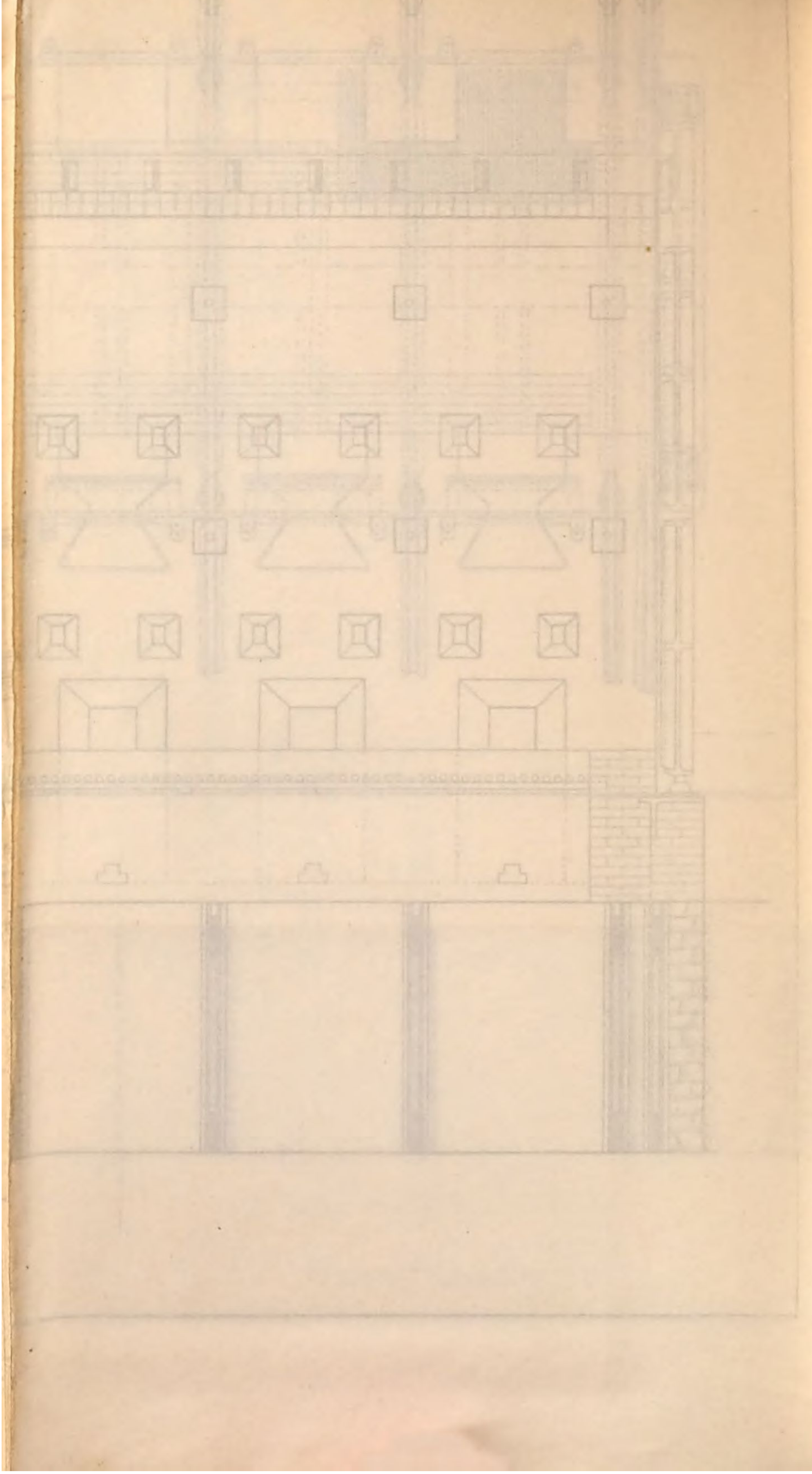
U.S. ARMOR PLATE FACTORY

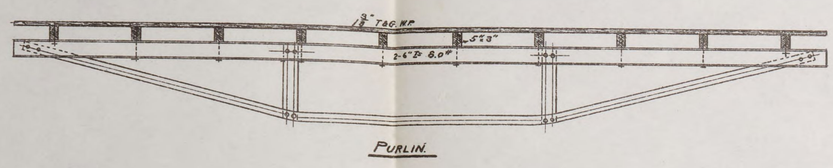
AS PROPOSED

7'×12'×36' TEMPERING FURNACES

32

SCALE ¼-2FT





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U. S. NAVY DEPARTMENT,
Armor Factory Board.
Nov. 24, 1891.
H. Bering Chambers,
LIEUT. & RECORDER.

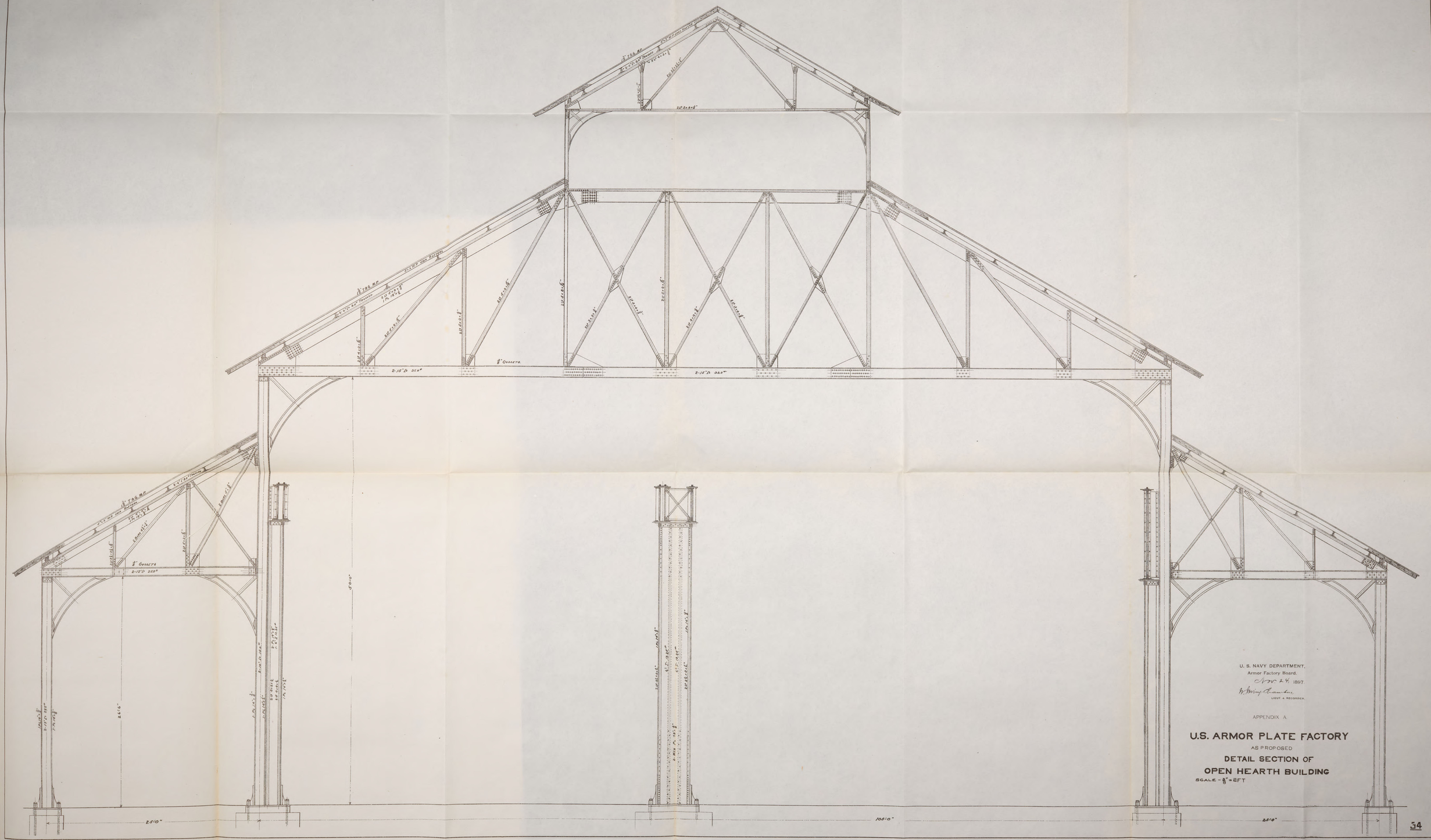
APPENDIX A.

U.S. ARMOR PLATE FACTORY

AS PROPOSED.

DETAIL SECTION OF 130'0" BUILDINGS

SCALE 1/2"=1FT.



U. S. NAVY DEPARTMENT,
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APPENDIX A.

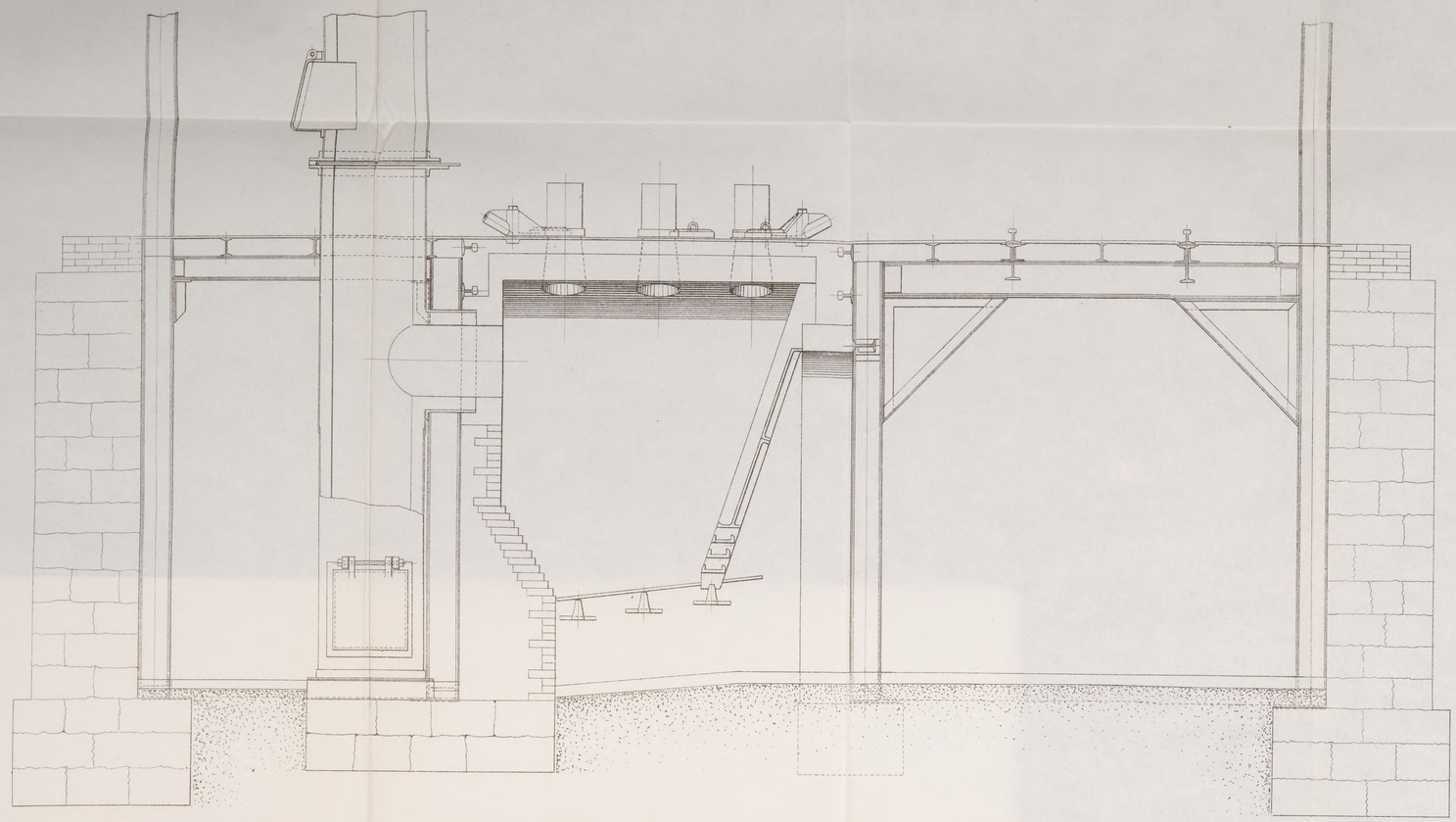
U.S. ARMOR PLATE FACTORY

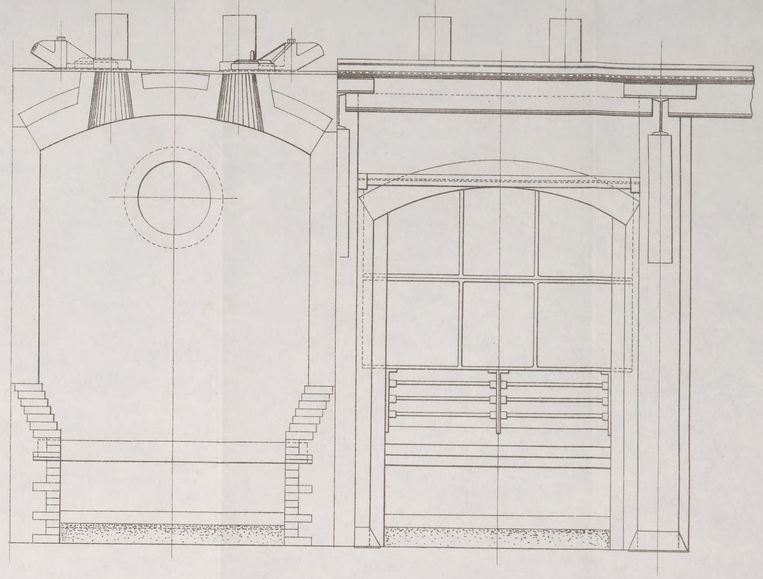
AS PROPOSED

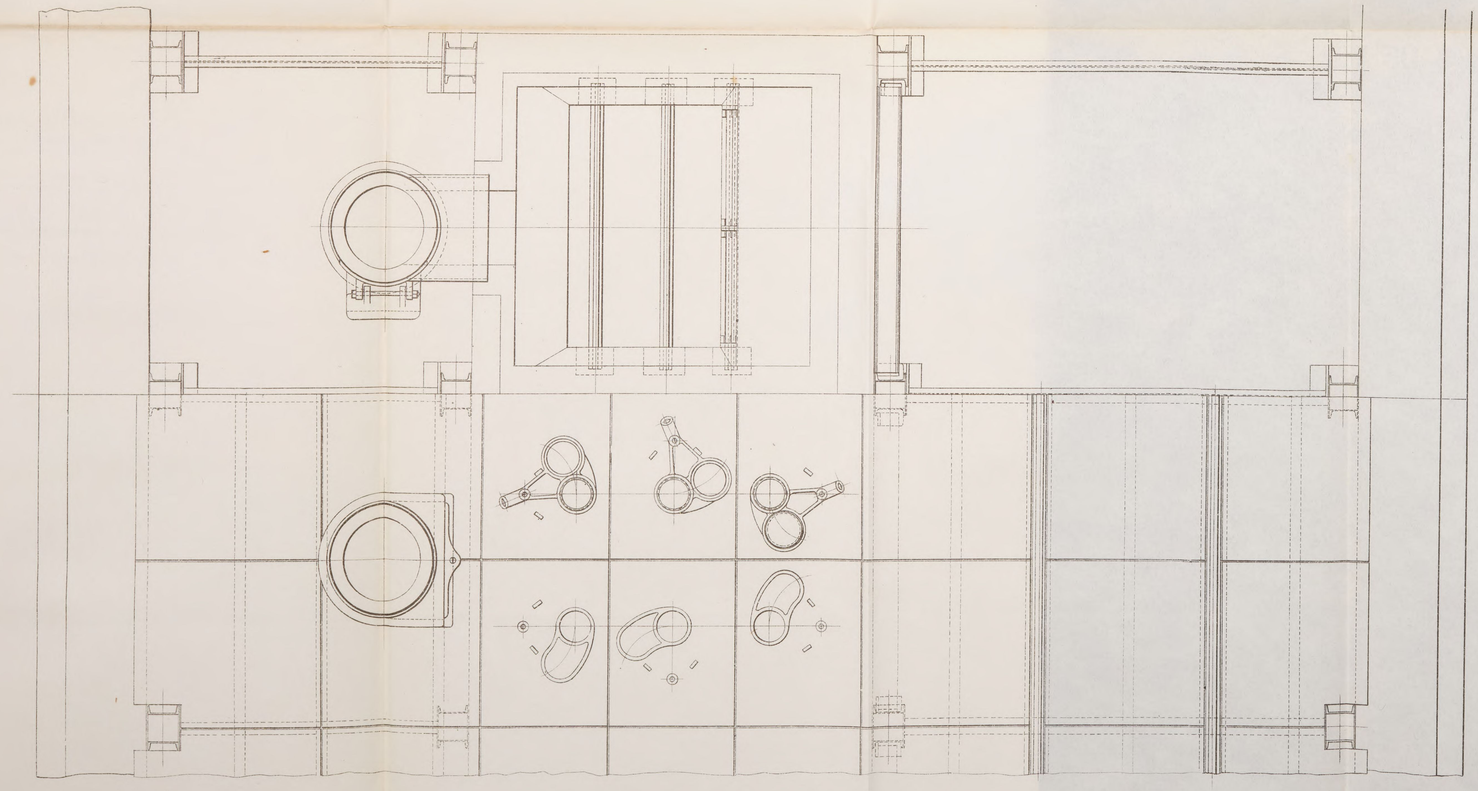
DETAIL SECTION OF OPEN HEARTH BUILDING

SCALE - 3/8" = 1 FT

H Doc 23—55 3







U. S. NAVY DEPARTMENT,
Armor Factory Board.
Nov 24, 1897.
W. Berry Chambers,
LIEUT. & RECORDER.

APPENDIX A

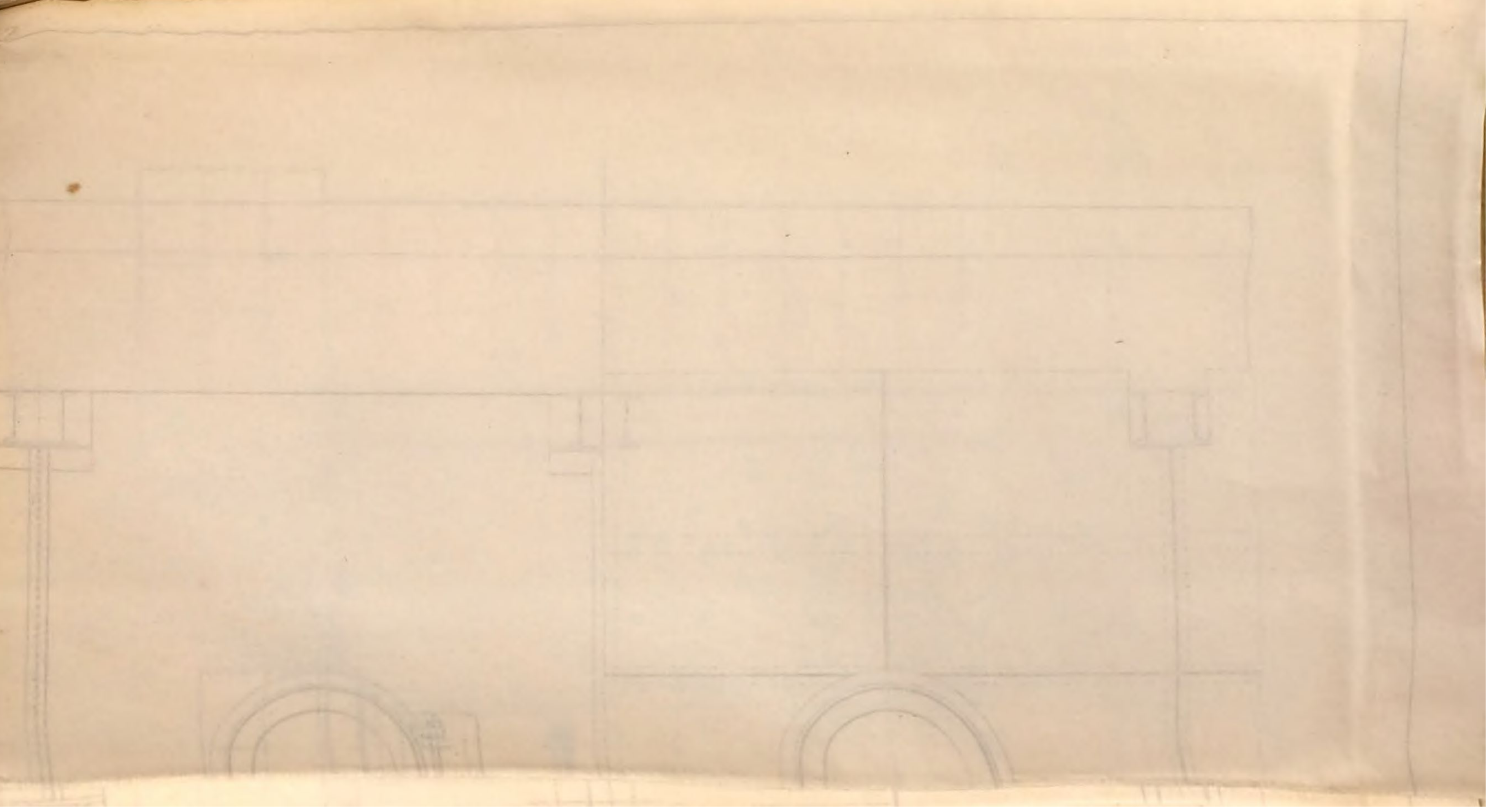
U.S. ARMOR PLATE FACTORY

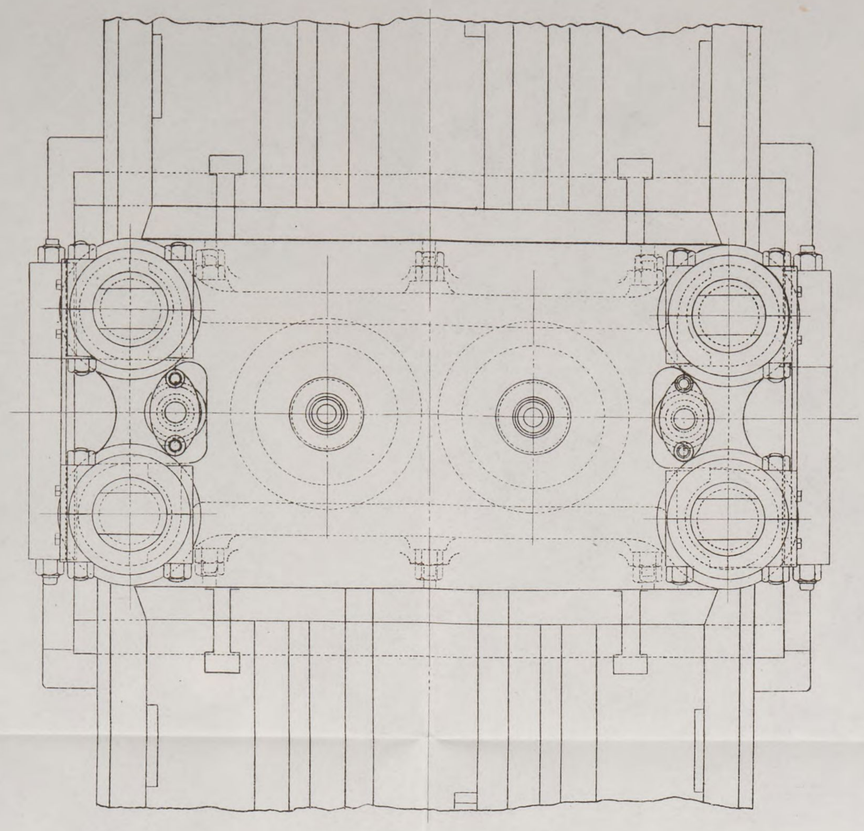
AS PROPOSED

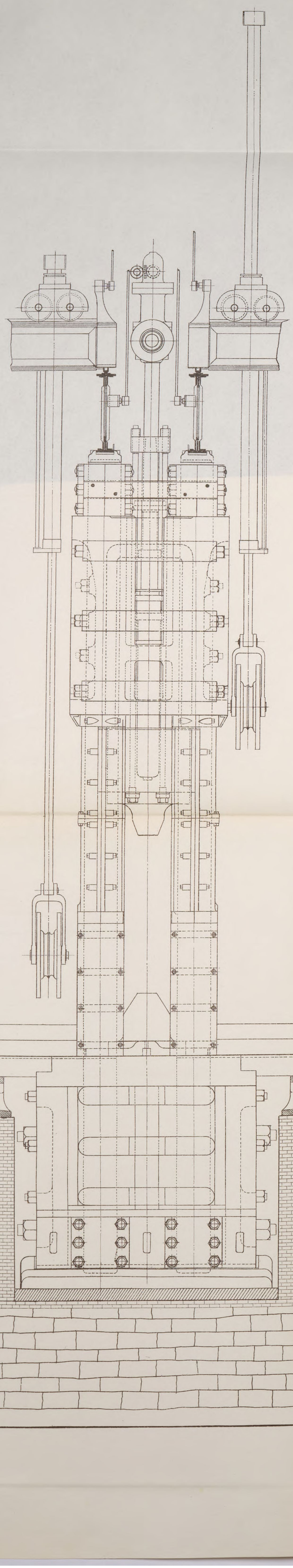
SIEMENS GAS PRODUCERS

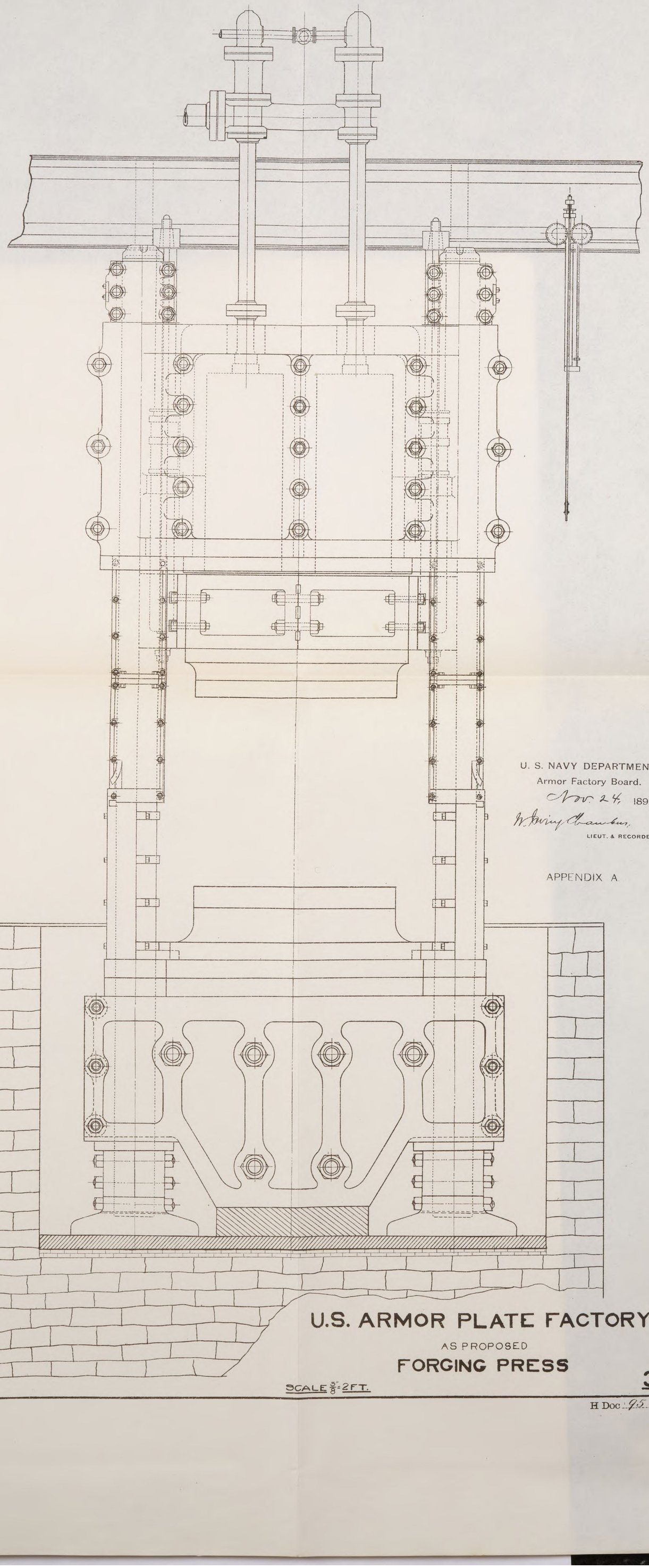
SCALE 3/4" = 2FT

H Doc. 23....55 2









U. S. NAVY DEPARTMENT.
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Nov. 24, 1897.
W. Irving Chambers,
LIEUT. & RECORDER.

APPENDIX A

U.S. ARMOR PLATE FACTORY

AS PROPOSED

FORGING PRESS

SCALE $\frac{3}{8}$" - 2 FT.

36

H Doc. 95 55 2

U.S. ARMOR PLATE FACTORY

AS PROPOSED

BENDING PRESS

SCALE $\frac{3}{4}$"=2FT.

U. S. NAVY DEPARTMENT.
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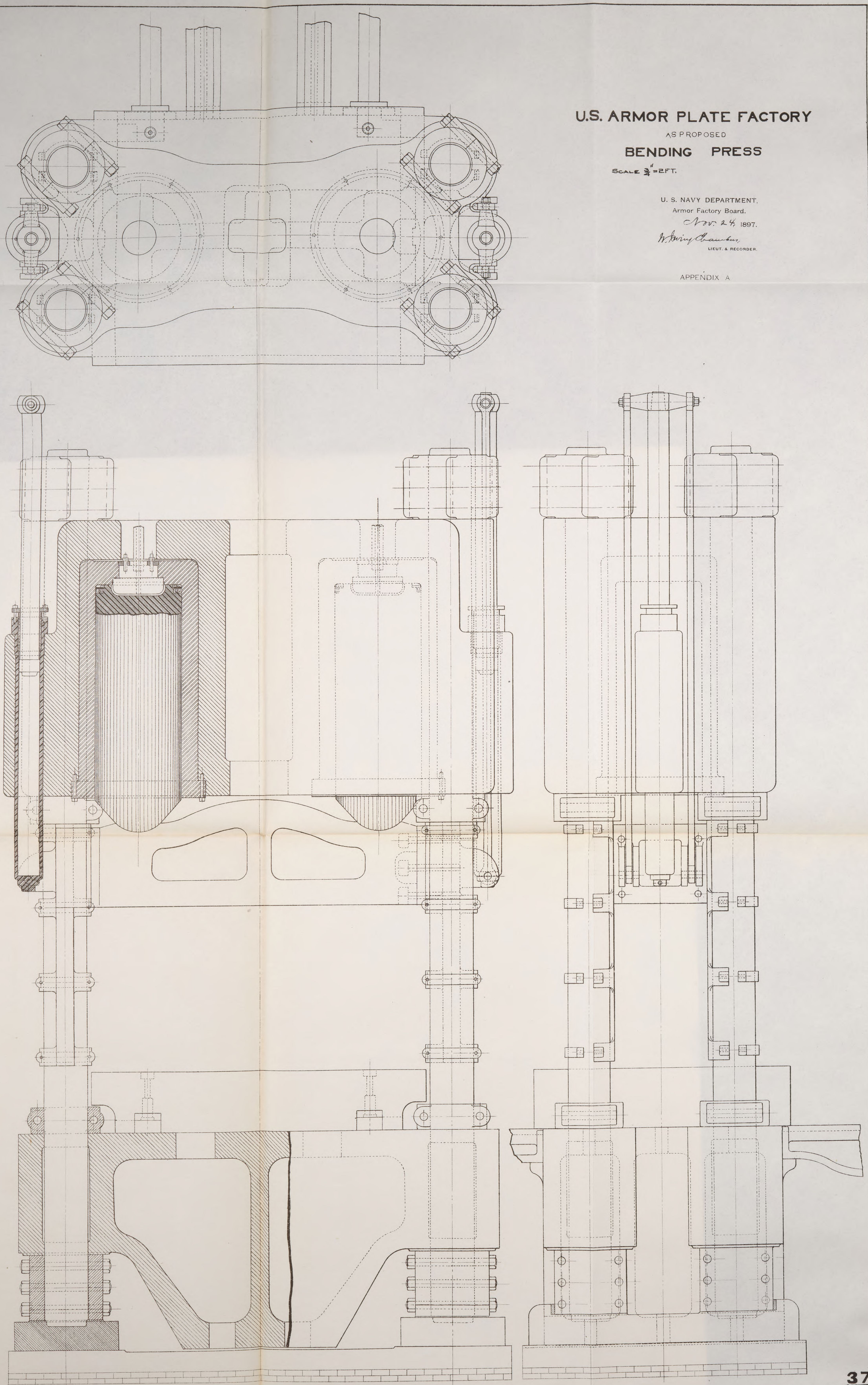
W. Irving Chambers,
LIEUT. & RECORDER.

APPENDIX A



H Doc. 75 55 2

APPENDIX B.

SPECIFICATIONS FOR BUILDINGS TO CONSTITUTE A PART OF AN ARMOR FACTORY FOR THE UNITED STATES GOVERNMENT.—TO BE BUILT IN ACCORDANCE WITH THE PLANS, TO FORM A PART OF THE CONTRACT.

LOCATION.

The buildings herein specified shall be erected on a site to be designated by the Navy Department, in the relative locations shown upon a general plan of the works, to be approved after the selection of a site, or as directed.

GENERAL CONDITIONS.

Facilities.—The Government will allow the contractor proper space at the site for depositing and storing materials, plant, and machinery necessary to be used in the construction of the several buildings.

After completion of the buildings, and before acceptance of the work by the Government, the contractor shall remove all machinery, surplus material, etc., from the station.

s *Patents.*—The use of all patented articles and methods employed in the con-atruction of the buildings is to be included in the contract price without any dditional charge or expense to the Government.

Intention.—It is the declared intention and meaning of the contract to obtain complete, substantial buildings, according to the general plans and specifications, to the entire satisfaction of the Navy Department. Any omission from both plans and specifications of details of the work, the performance of which is necessary to the construction, of which the officer in charge of the work shall be the judge, shall be done by the contractor as though fully described and shown, and without additional expense to the Government.

Control of work.—The Government shall at all times, by its officer in charge, have full direction and oversight of all work done under these specifications, and in all cases of dispute as to their intent and meaning the decision of the officer in charge shall be final, subject only to action by the Navy Department.

Time.—The contractor shall commence work within twenty days from the date of signing the contract and continue without interruption, the buildings to be completed within the limits stated.

Progress.—If at any time the progress of the work shall not have been such as to indicate that it will be completed within the times stated in the contract and specifications, the Government may in its discretion annul the contract and complete the work in such manner as it deems best, at the expense of the contractor and his sureties.

Unavoidable delays.—When an unavoidable accident, storm, or other act of Providence occurs, through which the progress of the work is or seems likely to be delayed, the contractor shall immediately notify the officer in charge of the occurrence in detail, and state in what way and to what extent it will delay the fulfillment of his contract, in order that the necessary investigation may be made and the matter put on record.

And it is clearly to be understood that unless it be done whenever such thing occurs, no subsequent application for an extension of time for completion of the work in question on account of such occurrence will be approved.

Avoidable delays.—Should the progress of the work be delayed by anything but unforeseen and unavoidable accidents, storms, or other acts of Providence, or by the acts of the Government, no application for an extension of time for the completion of the work or works in question will be recommended by the officer in charge for favorable consideration, except upon condition that the contractor make good any deterioration caused by the failure of the contractor to fulfill his contract with the United States according to the terms; and on granting the extension of time asked for there shall be reimbursed to the United States by the contractor the amount of such additional cost and expenses, to be deducted from any

money that may be or may become due him from the United States under his contract, the difference only to be paid him upon his receipt.

Extension of time.—No extension of time for completion of the work will be made except upon authority of the Secretary of the Navy.

Damages for delay.—In case the completion of any of the buildings shall be delayed beyond the time fixed upon, deductions of $100 per day as liquidated damages may, in the discretion of the Secretary of the Navy, be made from the contract price under which such building or buildings may have been erected, and such sum is hereby agreed upon in advance as the measure of damages to be suffered by the Government in consequence of such delay in the case of each building.

All expenses of every description that may be incurred in the prosecution of the work required must be covered by the contract price, as no extra allowance will be made.

Changes.—Should it be to the interest of the Government to make any change or changes in the plans and specifications exceeding $500 in value, the increased or decreased compensation to which the contractor may be entitled in consequence of such change or changes is to be determined by a board of naval officers, and the contractor shall be bound by their decision, and no further payments shall be made until their decision shall be accepted by the contractor in writing. Change in plans and specifications, not exceeding $500 in value, may be made by mutual agreement in writing, approved by the Department.

Upon completion of the work the surroundings shall be cleaned up without unnecessary delay.

The United States will not be responsible for any damage that may occur to the contractor's plant, or other property whatever, during the progress of the work or after, and he must assume all risks from storms, fire, damage to persons and property, and casualties of every description.

The officer in charge shall have power to reject any material which is not in accordance with the requirements of the specifications or drawings; and all rejected material will be at once removed by the contractor, and be replaced without delay with satisfactory material.

The contractor, in his own absence, must keep a responsible representative on the work to receive directions of the officer in charge.

The contractor shall be responsible for the entire line of work until final completion and acceptance by the Department.

Insurance to the full amount of the several payments shall be effected in such manner and in such companies as shall be approved by the Department, which insurance shall be renewed from time to time at the expense of the contractor, the loss, if any, to be stated in the policies as payable to the United States, for whom it may concern.

STRUCTURAL STEEL.

All structural steel shall be made by the open-hearth process.

All tests and inspections shall be made at the place of manufacture before shipment.

Test pieces.—The tensile strength, limit of elasticity, and ductility shall be determined from standard test pieces cut in the presence of the inspector from the finished material of each heat and planed, milled, or turned parallel, and have a cross section of at least one-half square inch; and the elongation shall be measured upon an original length of 8 inches, except when the thickness of finished material is five-sixteenths inch or less, in which case the elongation shall be measured in a length equal to sixteen times the thickness. Two test pieces shall be taken from each blow, one for tension and one for bending.

Finished bars, plates, and shapes must be free from injuries, seams, flaws, or cracks, and have a workmanlike finish.

Strength.—The structural steel used (except for rivets) shall have an ultimate tensile strength of 60,000 to 70,000 pounds per square inch, an elastic limit of one-half the ultimate strength, and a minimum elongation of 22 per cent in 8 inches, and must stand bending 180 degrees, without sign of fracture, to a curve the inner radius of which equals the thickness of the piece tested, both cold and after being heated to a cherry-red color, and then quenched in water of a temperature of 60° F., and have a reduction in area of not less than 40 per cent at the point of fracture.

Rivet steel.—All rivets must be of steel having an ultimate tensile strength of 52,000 to 60,000 pounds per square inch, an elastic limit of not less than 30,000 pounds per square inch, and an elongation of not less than 25 per cent in 8 inches, with a reduction of area of not less than 50 per cent at point of fracture, and stand bending 180 degrees and close down upon itself without sign of fracture. Speci-

mens must stand cold hammering to one-third the original thickness without flaying or cracking.

Variation.—The variation in weight or cross section of more than 2½ per cent from that prescribed will be sufficient cause for rejection.

Workmanship.—The workmanship must be first class in every respect. All abutting surfaces of compression members must be planed or turned to even bearings, so that they shall be in contact throughout. All finished surfaces must be protected by white lead and tallow.

Rivets must completely fill holes, have full heads concentric with rivets and in full contact with surfaces, and countersunk or heads flattened where required and machine-driven whenever practicable. The diameter of punch shall not exceed by more than one-sixteenth inch in diameter the rivets to be used, and driftpins will be allowed only for bringing together the several parts forming a member and must not be driven with such force as to disturb the metal about the holes. Built members must be, when finished, true and free from twists, kinks, buckles, or open joints between component pieces.

Painting.—All surfaces in contact with each other must receive one coat of red lead mixed in pure linseed oil. All work before leaving the shop must be thoroughly cleansed from all loose scale and rust and be given one good coat of pure linseed oil, well worked into all joints and open spaces. All surfaces that will be inaccessible after erection must receive one coat of iron-ore paint during erection, the iron to be perfectly clean before painting. After erection the structure will receive two coats of iron-ore paint of approved quality and color. All planed or turned surfaces must be coated with white lead mixed with tallow before shipment. No painting will be allowed during wet weather.

Working drawings.—Before anything is done on the steel work, one set of shop drawings must be sent to the officer in charge and be approved by him.

BRICKWORK.

All bricks to be hard burned, of best quality red brick, uniform in color and form. No arch or salmon bricks will be accepted. No bats will be allowed except for closures. All arches to be turned on centers.

All bricks must be laid wet, and mortar joints must not exceed one-fourth inch in thickness. The walls must be flushed every course, headers to occur every fifth course. No voids will be allowed in the brickwork and every brick must be laid solidly in mortar, bed, sides, and ends. Joints, wherever exposed to view, must be struck inside and out. All brickwork must be carefully protected from damage by the weather or other causes. All walls must be laid straight, level, and perpendicular, and closed around all steel work, and every space between brickwork and steel must be filled with mortar.

All bricks to be laid in mortar composed of one part of best quality lime and Rosendale cement in equal proportions, and two parts clean, sharp, screened sand.

MISCELLANEOUS.

All lumber, except where otherwise specified, will be of long-leaf yellow pine, of the best quality for the various purposes required. Any used for finishing shall be free from knots, sap, pitch, and other defects. Window sashes will be glazed with best quality double-thick American glass, well bedded, bradded, and back puttied.

Roofs of buildings to be covered with the best quality blue or purple slate, 20 by 10 inches, laid on lapped and stripped tarred roofing felt. The slates will be laid 3 inches double cover, each fastened with threepenny copper nails. The ridge courses and for 3 feet up from the eaves to be laid in elastic roofing cement. Ridges of roofs to be capped with 5-pound sheet lead, 12 inches wide, fastened by galvanized iron clamps 1 foot long, 1¼ inches wide, and three-tenths inch thick, screwed down, and spaced 3 feet apart. All flashing required must be done in the very best manner, to the entire satisfaction of the officer in charge.

All hardware must be of the best quality, and approved of by the officer in charge.

STONE MASONRY.

The stone masonry, wherever required in foundations, will be rubble, constructed of the best quality of hard, durable stone, laid in cement mortar, composed of one part clean, sharp sand and two parts of the best quality of Rosendale cement. The work shall be coursed. All stones used shall be of selected, large size, first quality, laid to lines on both sides, well fitted together, with frequent headers, not

less than one-fourth the whole, that extend well into the work. Stones must be clean and moist when laid, and laid upon their natural beds, and brought to an even bearing. No stones with a natural rounded surface shall be used. Stones to be roughly squared on joints, beds, and faces, and laid so as to break joints. The tops shall be capped with coping stones wherever needed and directed. All stones shall be firmly, solidly, and carefully laid, completely bedded in mortar, and the entire work thoroughly and completely flushed with the same.

All joints on the front of walls or piers, where exposed, shall be neatly and well pointed.

In making the mortar the cement and sand must be thoroughly mixed before any water is applied. The water is to be applied by sprinkling.

CONCRETE.

Concrete shall be made of one part of Portland cement, three parts of clean sharp sand, and five parts of broken stone or clean sea-washed silica gravel. The concrete shall be made by thoroughly incorporating the cement and sand in a dry state before any water is added. It is then to be moistened with a sprinkler and mixed until it attains a proper consistency, when it is to be spread upon the layer of broken stone or gravel previously moistened, and thoroughly mixed by being turned over not less than three times before being conveyed to the place of deposit. It is then to be spread in layers and well rammed until moisture collects on the surface. The cement must stand a tensile strain of 400 pounds per square inch after the usual seven days' test.

FOUNDATIONS.

All excavations necessary for the foundations will be made, and the surplus material removed will be used for leveling or grading where necessary, and any that may not be required will be removed from the limits of the armor-factory site. After the foundations are laid, earth will be filled back and settled or rammed.

The foundations will be constructed as shown, unless the character of the site to be determined upon shall require modifications.

No piling is shown in the foundations, and if the character of material should require it, or any other change be rendered necessary, modified plans will be made, and the change in the contract price proper to be made will be determined under the terms of paragraph 14.

The piers are topped out in brickwork, as shown in sheet No. 33, and holding-down bolts are to be built in as shown, with ample washers, nuts, etc.

If any discrepancies occur between the general drawings and the details, the latter shall govern.

OPEN-HEARTH BUILDING.

The open-hearth building is to be about 494 feet long by 153 feet wide, and one story. It is to have a central aisle and clere-story, and side wings.

The construction is to be a steel frame, the columns resting upon isolated piers, with curtain walls of brick resting upon steel girders spanning the spaces between outside columns.

The end walls, of brick, will rest upon continuous foundations of rubble masonry of the same thickness as the piers, 4 feet wide at foot and 5 feet deep.

The roofs are to be sheathed with $1\frac{3}{8}$-inch lumber, of white pine, and covered with slate laid upon two thicknesses of tarred roofing felt of acceptable quality.

The interior columns will be spaced, as shown, 23 feet apart, and where one is omitted the space is to be spanned by a girder properly proportioned to carry the loads to the columns.

The interior columns and girders for crane tracks are to be capable of sustaining the cranes with a load of 160 tons.

The gas-producer house, which is to be a part of the open-hearth building, is to be of the same general construction as to type. Details and dimensions to be submitted by bidders.

The superstructure is to be in accordance with the general plans and specifications, and bidders must submit with their proposals details of the steel work, showing the full construction, and accompanied with strain sheets showing the strains in the various members and the sections proposed where the details are not given.

There will be five chimneys of steel plate, lined with fire bricks, of the dimensions and construction shown upon the drawings, sheet No. 18, for an 8-feet-diameter chimney.

The foundations of piers, chimneys, and walls for casting pits, gas-producer pits, flues to chimneys, etc., will be built in substantial accordance with the drawings.

The entire construction must be of the best material and workmanship, and carry out the true spirit and intent of the plans and specifications.

The windows in the side walls of wings are to be double hung and perfectly balanced. Those in the clere-story and ventilator are to be made to swing, with a satisfactory device for operation.

Columns, girders, roof framing, etc., are to be in accordance with the general drawings and the details shown upon sheet No. 34.

The purlins will be of the same detail as those shown on sheet No. 33.

STOCK HOUSE.

A stock house will be erected in the position shown upon the plan of the works, 150 by 62 feet, one story in height.

It will be of brick, with a steel roof frame, and a roof covering of slate.

The bidders must submit a plan showing the details proposed.

FORGING AND CEMENTING SHOP.

The forging and cementing shop is to be about 833 feet 3 inches long by 131 to 171 feet in width, exclusive of the gas-producer houses.

The construction is to be a steel frame supported upon piers with curtain walls of brick 13 inches or 1½ bricks thick. The ends are to be 2½ bricks thick, and rest upon continuous foundations.

The roofs are to be boarded with T and G white pine, 1⅜ inches thick, and covered with slates laid upon a double thickness of tarred roofing felt, and framed in steel in accordance with the details shown on plans, sheet No. 33, for the portion 131 feet wide. For the portion 171 feet wide the main span will conform to the same, but the bidder must submit a detail for the trusses in the wings, with dimensions of parts.

All the windows in side and end walls and in clere-story are to be double hung and well balanced.

The gas-producer houses are to be regarded as parts of the forging and cementing shop, and are to be of the same type of construction. They are shown only in outline by the columns in the general plan, sheet No. 4. There will also be 24 chimneys, of steel plates, and lined with fire bricks, and constructed in accordance with the detail drawings for the same, sheet No. 18, for a 7-feet-diameter chimney.

The interior columns, girders for crane supports, tracks, etc., are to be proportioned for a crane load of 160 tons at the forging press and 100 tons throughout the building's length.

The superstructure must be in accordance with general plans and details, as far as shown or described, and where these are not full enough to show all features of construction the bidder must show or describe what he proposes to supply.

The foundations for the piers, pits, etc., must be in accordance with the plans, and any further directions necessary. The sheets of plans to which reference is made are numbers 4, 5, 6, 7, 8, 18, and 33.

BENDING AND TEMPERING SHOP.

The bending and tempering shop is to be about 505 feet long by 130 feet wide.

It is to be a steel-frame structure with the columns carried by masonry piers. The side walls are curtains carried upon steel girders extending from column to column. The end walls are 2½ bricks thick, and rest upon continuous masonry walls, 3 feet on top, 4 feet on bottom, and 5 feet deep. The side walls are 1½ bricks thick.

The gas-producer house is of the same type, the outline in plan shown by location of the columns in sheet No. 13 of the drawings.

The building is divided into a central aisle and two wings by the rows of interior columns carrying the traveling cranes.

The roof is sheathed with 1⅜-inch white-pine boards, upon Z-bar purlins, and covered with slates laid on a double thickness of tarred roofing felt.

The interior columns and girders are designed for the support of 75-ton cranes.

The building is to be provided with two oil tanks, located as shown, and of the construction shown on sheet 15 of the drawings. The tanks will be constructed of steel, the floors being one-half inch thick and the sides three-eighths to one-quarter inch thick, made in the best manner.

The lower windows will be double hung, but those in the clere-story will be made to swing and be controlled.

The masonry piers and tank walls, etc., will be constructed as indicated upon the drawings.

There will be 4 chimneys, to be of the dimensions, details, and foundations shown upon sheet No. 18 for a 7-feet-diameter chimney.

The gas-producer house will be a part of this structure, and of the length indicated upon sheet 13. It is of the same general character as the main building. Bidders will submit a sheet giving details and dimensions.

The roof trusses, framing, columns, girders, etc., will be in accordance with details on sheet No. 33, and details not shown will be supplied by the bidders.

MACHINE SHOP.

The machine shop will be 830 feet long by 131 feet wide, one story in height, the central aisle containing a clerestory, with double-hung sashes for light and ventilation. There are wings on either side under single pitch roofs.

The construction is a steel frame, with side walls as curtains resting upon steel girders extending from column to column, the end walls resting upon continuous masonry foundations. The side and interior columns rest upon isolated piers.

Doors will be constructed in the situations shown, and of the design illustrated. They will be of white pine, 2 inches thick, paneled on the face as shown, and substantially hung and fitted with approved hardware.

The curtain walls will be 1½ and the end walls 2½ bricks in thickness.

The foundations will be rubble masonry of the dimensions shown, those of the end walls to be 3 by 5 feet deep.

The roof trusses, framing, columns, girders, etc., will be in accordance with details shown on sheet No. 33. Details not shown will be presented by the bidder. Crane supports to be for 75-ton cranes.

The roof covering will be of slate, on 1⅛-inch white-pine boards, tongued and grooved, with a double layer of tarred roofing felt between.

The machine shop will be floored with 3-inch oak plank, resting upon oak sleepers, 12 by 12 inches, spaced 4 feet from center to center.

ERECTING SHOP.

The erecting shop will be 305 feet long by 131 feet wide and one story in height. It is divided into a central aisle and side wings by rows of interior columns, carrying the roofs and the crane tracks.

The structure is a steel frame, carrying the brick side walls upon steel girders, the end walls being carried by continuous masonry wall foundations of the same depth as the piers supporting the columns.

The roof trusses are of steel, in accordance with the design, spaced with the columns, and carry a roof covering of 1⅛-inch sheathing, upon which is laid the slate, with a double layer of tarred roofing felt between. The purlins are Z-bars, as shown.

All the sashes, except those over doors, are double hung.

Doors 2 inches thick are to be built where shown, substantially made, hung, and trimmed.

The foundations are of rubble masonry and of the dimensions shown.

The floors in this building are to be of yellow pine and concrete, of the detail shown upon the section of the building.

The roof trusses, framing, columns, girders, etc., are to be in accordance with the details shown upon sheet 33. Details not shown will be submitted by the bidder. Crane supports must be for a 75-ton crane.

Side walls are 1½ and end walls 2 bricks in thickness, respectively.

BLACKSMITH SHOP.

The blacksmith shop will be 201 feet long by 71 feet wide and one story high, the roof carrying a louver.

The frame is of steel, the roof trusses being borne by columns resting upon piers, and the walls carried by steel girders from pier to pier.

The lower sashes are to be double hung, and those in the louver to swing.

The roof coverings to be of slate, resting upon 1⅛-inch pine sheathing, with a double layer of tarred roofing felt between.

Doors to be located where shown and constructed in accordance with the general plans.

The foundations are to be of rubble masonry of the dimensions shown.

The roof is in one span. Its details will correspond with those shown for the central span upon sheet No. 33 and the columns will correspond with the side columns shown thereon. Details not shown or given will be presented by the bidder.

BOILER HOUSE.

The boiler house to be 241 feet long by 96 feet wide.

The walls are of brick, 13 inches thick, and are carried by girders spanning the spaces between columns.

The structure is otherwise a steel frame.

The roof covering is of slate laid directly upon a double thickness of tarred roofing felt, resting upon $1\frac{3}{8}$-inch white-pine sheathing.

The windows in walls are to be double hung and balanced, while those in the louver are to swing, and be controlled.

There will be two chimneys of the dimensions and construction shown in the details for a 10 feet diameter chimney, on plan No. 18.

The foundations for the columns and chimneys and the flues will be constructed as indicated in the drawings, the flues being shown in outline only.

Sheets 9, 10, and 18 of the drawings are referred to.

The bidder will submit a strain sheet, with dimensions of all the parts proposed in the roofs, columns, girders, etc.

POWER HOUSE.

A brick building, 200 feet long by 96 feet wide, one story in height, with steel roof and slate covering, will be erected for the accommodation of the electric generators.

The bidder will submit plans and details of this building, including its foundations, but not the foundations for the machinery. The latter will be included in the plans and bids for the electric plant.

LOCOMOTIVE HOUSE.

The locomotive house will be 127 feet long by 52 feet wide, one story in height.

The building will be of brick and steel. The four roof trusses rest upon columns in the side which seat upon piers. The end walls rest upon continuous masonry foundations. All walls are $1\frac{1}{2}$ bricks in thickness.

There will be eight steel stacks with hoods passing through the roof, thoroughly flashed and well secured.

The roof will be of slate, laid on a double layer of tarred roofing felt and $1\frac{1}{4}$-inch pine sheathing boards.

There will be two pits, walled as shown, with rubble masonry, and provided with drains leading to the sewer in the street.

The foundations will be of rubble masonry of the dimensions shown.

Doors will be $1\frac{1}{2}$ inches thick where indicated upon the drawings, and of the construction shown, well and substantially hung.

Sashes will be double hung.

Bidders will submit strain sheets and dimensions not shown.

LABORATORY.

The laboratory will consist of two main apartments, connected by a passageway of the same character as the main structure.

Each apartment will be 50 by 50 feet upon the exterior, and the connecting hallway will be 20 feet long by 12 feet wide, outside dimensions.

The structure will be of brick, one story in height, and have a louver ventilator over one apartment, and four chimneys in the other. The roof framing will be of steel and covered with slate, laid upon tarred roofing felt and $1\frac{1}{4}$-inch pine sheathing. The walls, $1\frac{1}{2}$ bricks thick, will rest upon continuous rubble foundations, of the dimensions shown.

The walls will be lathed and plastered, 3-coat work.

The roof sheathing must be of narrow dressed yellow pine.

The doors and window sashes must be of clear white pine.

The woodwork outside must be finished in three coats of pure white lead and oil, in colors as directed, and the interior woodwork finished in a natural color in oil, and all exposed steel work painted three coats in colors as directed.

The chimneys above the roof line must be laid in cement mortar, and well flashed and counter-flashed.

The floors will be double, the lower layer to be of good merchantable pine, laid diagonally; the upper layer to be of narrow, well-seasoned, clear yellow pine. Each layer to be 1 inch in thickness.

The laboratory is to be piped for cold water supply, and for steam, and is to have radiators of approved pattern and dimensions installed. The steam pipes will be connected with the nearest main.

OFFICE BUILDING.

The office building will be 98 feet 10 inches long by 49 feet 6 inches wide, and two stories in height.

It will be constructed of bricks, with a timber frame roof, covered with slate laid on a double row of tarred roofing felt, and 1¼-inch pine sheathing.

The outer walls will rest upon continuous rubble masonry foundations of the dimensions shown. Rubble masonry piers will carry the lower floor girders, upon which the floor joists will rest inside the main walls. The outer walls will be 1½ bricks in thickness.

The first and second floors will be partitioned as shown upon sheet 24 of the drawings. The hall partitions in the first story will have heavy posts to carry girders, upon which the second story floor joists will rest inside the main walls.

The walls and ceilings will be lathed and plastered, 3-coat work, the finish being hard and white. The walls in both stories will be wainscoted to a height of 4 feet, in narrow beaded yellow pine, and finished in hard oil.

The floors will be of narrow yellow pine, of clear stuff, and finished in oil. The lower floor will be double, the bottom course being run diagonally.

There will be water-closets fitted up where shown on both floors, complete with urinals and basins. The closets, urinals, and basins must be of the most approved pattern and quality, and the water-closets and basins must be in openwork, no inclosures being allowed. There will be no wainscoting in the closets. The soil pipes will be led outside the walls of the building, ready to be continued to the sewer when the drainage system is constructed.

The building and all apartments will be piped for steam heat, with radiators of approved patterns and dimensions. The steam will be led to this building from the nearest main and connected with the pipe system.

It will also be piped for hot and cold water in the water-closets.

The framing lumber will be of yellow pine of the best merchantable quality. All doors and sashes will be of white pine of clear quality.

All wood inside will be finished in natural color in hard-oil finish. All exterior work will be painted three coats of pure white lead and linseed oil in colors as directed.

Details and dimensions not given will be submitted by the bidders.

WATER-CLOSETS.

Two water-closets will be erected upon the site and fitted up with closets and urinals. Plans for the buildings and fittings will be prepared by the contractor to meet the approval of the Navy Department, and they will be erected and fitted complete, connected with water supply and drainage systems, by the contractor for the buildings, for which he will be paid the actual cost plus 10 per cent upon verification of such cost by the Department.

SPECIFICATIONS FOR WATER SUPPLY AND DRAINAGE FOR UNITED STATES ARMOR FACTORY.

WATER SUPPLY.

The contractor for the buildings, etc., will be required to provide an adequate supply of water for all purposes of the factory, and for its distribution throughout the works, upon plans, details, and specifications to be approved of by the Navy Department, and will receive as compensation the actual cost plus 10 per cent.

The plans and specifications will be submitted by the contractor, after the site for the factory has been determined upon. Full exhibit to the Government of such actual cost will be made by the contractor for its verification and approval.

DRAINAGE.

The contractor for the buildings will be required to submit plans, details, and specifications for a system of drainage, after the site for the factory has been determined upon by the Navy Department, and such a system as shall be approved

by the Navy Department, must be constructed by the contractor, and the compensation he will receive will be the actual cost plus 10 per cent. A full exhibit of such actual cost will be made to the Government for its variation and approval.

SPECIFICATIONS FOR RAILROADS.

There will be a standard-gauge railroad constructed in the location shown in the plans.

The rails must be the best quality American steel, the weight to be 75 pounds per linear yard.

They must be 30 feet in length. Ten per cent of their number will be allowed of shorter length down to 24 feet, but all must be of an even number of feet.

An allowance of 2 per cent in weight each way for individual rails will be made.

Ends must be cut square with the axis of the rails and show a smooth surface without defect.

The surface of the rails must be smooth and without defect, such as cracks, blisters, welding seams, etc.

The punching or drilling must not vary more than one thirty-second of an inch from the dimensions and spacing required, and must show no projections.

Each rail must be marked with the maker's name and the year in which rolled.

The joints will be made with angle plates of steel.

The bolts will be of best quality and of proper length for the Harvey lock nut.

The frogs will be stiff, of steel 75 pounds rail, and riveted to wrought-iron plates, the rivets to be countersunk on the under side.

The switches will be split, of 75 pounds steel rail, 15 feet in length, with throw of 3½ inches. The gauge to be 4 feet 8½ inches. They will be of the Lorenz pattern, and complete with switch rods, connecting rods, and wrought-iron plates, etc. They will be single throw.

The switch stands will be of the ground lever or tumbling pattern, complete with switch rod.

The ties must be 8 feet long by 7 by 6 inches face in the main tracks, and correspondingly longer in switches and crossings. They must be of young living timber, oak, chestnut, cedar, or other approved wood, sound and free from all defects impairing their strength and life. They must be sawed or hewn true to sizes. They will be spaced 2 feet centers.

The track must be thoroughly spiked with spikes of approved size, evenly graded, well tamped, true to alignment and gauge.

There will also be a narrow-gauge track system of 3 feet gauge. The rails will be of 60 pounds per linear yard. The ties will be 6 feet long by 7 by 6 inches face, and laid 2 feet centers.

The provisions as to the character and quality of the materials and workmanship prescribed for the standard-gauge track will apply equally to the narrow-gauge track.

The plans show the location and extent of the two systems.

SPECIFICATIONS FOR LAND FOR SITE OF UNITED STATES ARMOR FACTORY.

The land required for the establishment of an armor factory will comprise about 140 to 160 acres. This land should be situated in a section of the country free from sudden attack by an enemy. It should be near places where the production of iron and steel are well developed, and where there is an industrial population from which skilled labor may be drawn. It should be near railroads having ample facilities for transportation to the seaboard, as well as near sources of supply of the necessary fuel. The section of country in which it is located should possess good climate throughout the year.

The location should be near a good water supply and possess facilities for easy drainage, for connecting with railroad lines, and for dumping refuse slag, cinder, etc. The ground should be of such a character as to admit of good foundations at moderate cost. It should also be capable of being brought to proper and easy grades at moderate expense.

SPECIFICATIONS FOR MACHINE TOOLS IN MACHINE SHOP.

UNIVERSAL BORING, DRILLING, AND MILLING MACHINE.

The machine to consist of a heavy column with a circular base, on which it may be swiveled by hand or power, resting on a carriage, which traverses by hand or power on a massive bed; table to be of sufficient size to take plate of 10 by 24 feet

finished size. On the face of the column to be a counterweighted saddle which traverses vertically, by hand or power, carrying a steel spindle at least 8 inches in diameter, with 4 feet traverse, by hand or power, or by variable feed motion. Traverse of column on bed, of saddle on column, and the swiveling of the column horizontally on its axis, to be arranged to be operated either rapidly by a quick traverse gear or slowly for feeding in any direction and for fine adjustment by hand. Spindle also to swivel on saddle in a vertical plane.

Driving cone 33 inches diameter with 5 steps for 5-inch belt, arranged to give 15 changes of speed.

Feed cones 16 inches diameter with 4 steps for 3-inch belt and geared for 8 changes of feed.

Vertical feed screw to be of steel and at least 4 inches diameter. Traverse of column on bed by steel rack and pinion, $4\frac{3}{4}$-inch face and 2-inch pitch.

Feed to vary from one one-thousandth inch to $2\frac{3}{4}$ inches per minute.

The machine to be of sufficient size to finish a plate of 10 by 24 feet.

OPEN-SIDE PLANING MACHINE.

To plane edges of plates 10 feet by 24 feet by 18 inches finished size and to cut in both directions.

The machine to consist of a massive bed on which a heavy saddle will traverse, carrying a tool slide with vertical adjustment of $3\frac{1}{2}$ feet and in-and-out adjustment of 2 feet. On one side of the bed is to be a work table of ample length and about 46 inches wide, with pit outside to accommodate curved plates.

Countershaft to give four cutting speeds, viz, 4–8–12–16 feet per minute.

Diameter of lead screw to be at least 5 inches.

Pulleys to be 36 inches diameter for 6-inch belt.

Feed motions to vary from one-twentieth to eight-tenths inch.

To have hand adjustments for vertical and horizontal movements of tool slide.

PIT PLANING MACHINE.

To consist of two massive beds placed opposite each other, about $15\frac{1}{2}$ feet apart, united at each end by heavy cross braces, and securely bolted to substantial foundations. On each bed, and traversing it by a steel screw at least 7 inches diameter, will be gibbed a heavy slide, about 18 feet long, carrying two planer uprights, united at their tops by rigid cross braces with the similar uprights on the opposite slide. These uprights will have their vertical faces opposite each other, and each pair will carry a planer cross slide carrying two cutting heads, which are independently self-feeding in all directions. Two cutting heads will be engaged when the planer is moving in one direction, and the other two when moving in the opposite direction.

The cross slides are to raise and lower by power at least 4 feet.

The tool slides are to be counterweighted, are to swivel, and are to have 30 inches traverse by hand or self-feed.

Face of cross slides, at least 37 inches.

Width of saddles, at least 37 inches.

Steel operating screws, 7 inches diameter.

Pulleys, 54 inches diameter for 7-inch belts.

CUTTING-OFF PLANING MACHINE.

The machine to consist of two massive beds, placed opposite each other, united at their ends by rigid cross braces and securely bolted to solid foundations. Two pairs of uprights, united by strong cross braces at their tops, are adjustable by power to any desired point on the upper side of the beds. Each pair of uprights, with its cross bracing, to form a stiff framing extending across the machine from side to side and to be gibbed to the beds on each side.

Between each pair of uprights, and gibbed to their inner faces, will be a heavy cross slide, which is adjustable by power and feed through a distance of 4 feet; it will carry a planer-head that cuts crosswise of the machine; this latter cross slide is to be fitted to rotate on its axis so as to present the tool to the work at any desired angle for bevel cutting; tool slide to have a traverse of 30 inches.

Machine to be of sufficient size to trim off sides and ends of plate 10 by 24 feet, finished size.

Feed screws in cross slides to be at least 6 inches diameter.

Feed and traverse screws for uprights to be at least 5 inches diameter.

Face of cross slide, 38 inches.

Face of uprights, 42 inches.

Base of uprights on bed, 8 feet.
Cutting speeds, 5–10–15 feet per minute.
Feeds to range from one thirty-second to three-fourths inch by ratchet.
Cross and tool slides to be counterweighted.
Driving pulleys, 54 inches diameter for 7-inch belts.
Counter pulleys, 48 inches diameter for 12-inch belts.

POST PLANING MACHINE.

To plane plates 10 by 24 feet by 18 inches, finished size.

To consist of heavy column, traversing by power on a massive bed, on one side of which is placed a heavy work table. On the face of the column a counterweighted saddle will traverse vertically at least 12 feet. The saddle will be provided with a tool slide, arranged to cut in both directions horizontally and also in both directions vertically. The slide also to have a horizontal in-cutting motion, by hand or automatic feed, of 20 inches. Both column and saddle are to be readily adjustable by power to any position and to any stroke within their respective traverses.

Countershaft to be arranged for four speeds suitable for cutting at rate of 4–8–12–16 feet per minute.

Pulleys, 36 inches diameter for 5-inch belt.

Diameters of lead screw for both horizontal and vertical planing, at least 5 inches.

Feeds to be variable from one-twentieth to eight-tenths inch by five gradations.

If a motor can be furnished that will give the necessary change of speed, the countershaft can be omitted.

UNIVERSAL DRILLING MACHINE.

To consist of transverse bed plate, arranged to allow a track to be attached to it, on which a suitable truck or carriage may be rolled for carrying the work to be drilled. Carriage to have traverse of 24 feet.

On this bed plate will be secured two rigid columns, at least 14 feet apart, united at the top by a strong cross brace. A heavy counterweighted cross slide, with one drilling head, will be gibbed to the columns and adjusted vertically on them by power to a height that will allow of drilling on the top of a plate of 10 feet high above the carriage or truck.

The cross slide to be arranged to rotate by a worm gear and the drilling head to swivel, so that a hole may be drilled at any angle. The drilling head to be adjustable along the cross slide by a rack and pinion.

Diameter of spindle, at least 5¾ inches.
Traverse of spindle, 37 inches.
Face of cross slide, 38 inches.
Face of columns, 30 inches.
Base of columns, 60 inches.
Cone, 30 inches diameter for 5-inch belt, with 4 steps.
Counter pulleys, 24 inches diameter for 6-inch belt.

ROTATING OR CIRCULAR PLANING MACHINE.

The machine to be of sufficient size to plane off the edges of plates 10 by 24 feet by 18 inches, finished size.

To consist of a massive bed on which traverses, by power, a heavy saddle carrying a revolving disk 84 inches in diameter at the cutting circle. This disk is to be held by a spindle 16 inches diameter and 4 feet 8 inches long in a transverse slide, with 4½ feet in and out adjustment. The disk will have near its outer periphery an internal gear driven by a pinion like a face-plate lathe, so that the driving power shall be applied at the point of cut and not transmitted through the spindle.

The saddle to have quick traverse by power in both directions.

A heavy work-table will be on one side of the bed of sufficient size to take a plate 10 by 24 feet.

Speed of cutters to be adjustable from 10 to 50 feet per minute. Feed to be made fine or coarse as desired.

EMERY GRINDING MACHINE.

For plates up to 24 feet long, 10 feet wide, and 18 inches thick.

The machine is to consist of a suitable bed, on which is gibbed a carriage, traversing it automatically by power, like a planing machine, and adjustable to any stroke within its range.

The carriage to be provided with a vertical slide, carrying an emery wheel of about 22 inches diameter by 3 inches face, and having 24 inches hand adjustment; also with a horizontal slide having 24 inches in and out adjustment by hand.

The emery wheel will be operated by a driving shaft along the bed and belts and swing frame. Diameter of shaft, 3 inches; speed of emery wheel, 1,040 revolutions per minute.

ONE PLATEN PLANER

12 feet between upıights; to plane 25 feet in length and 6 feet over platen. To have two saddles on cross slide and one saddle on each upright; one saddle to have power transverse cutting travel with quick return; platen to be driven by rack and cut gearing and to have quick return; all saddles to be swiveled and adjustable by power.

ONE PLATEN PLANER

6 feet by 6 feet between uprights and to plane 20 feet in length; to have two saddles on cross slide; saddles to be swiveled and adjustable by power; platen to be driven by gearing and to have quick return.

ONE SHAPER

with traveling head; stroke to be at least 18 inches; travel of head, 72 inches; to have two tables, adjustable vertically and horizontally by rack and screw; saddle to be traversed by rack and pinion operated by hand ratchet.

Traveling head to have quick transverse motion with rack and pinion operated by hand wheel; also to have open and shut nut provided within easy reach of operator which can be quickly closed and ordinary feed motion of machine used.

Ram to be operated by Whitworth quick-return motion.

Crank plate to be graduated in fractions of an inch with corresponding line on crank washer. Tool head to be provided with clamps and to have down feed of 8 inches.

To have circular attachment and cone washers.

To be furnished with swiveling vise for work, wrenches, countershaft, and all attachments necessary for its operation.

SPECIMEN CUTTING MACHINE.

To consist of a bed on which a short column traverses by power, carrying a drilling saddle provided with automatic feed and hand motion, the saddle to be adjustable by hand on the column.

Diameter of spindle, 4 inches.

Traverse of spindle, 18 inches.

Horizontal traverse of column, 26 inches.

Vertical traverse of saddle, 26 inches.

SPECIFICATIONS FOR SMALL TOOLS IN MACHINE SHOP AND TOOL ROOM.

One platen planer, 20 by 20 inches between housings, with 4-feet traverse of platen; the feed to be variable and self-acting at all angles and at either end of cut; platen to have quick return; motion to be so arranged that platen may be stopped at any position by the reverse lever while the belts are running; motion to be by rack and cut gearing.

One horizontal boring and drilling machine, to be capable of drilling and boring in the center of a circle 54 inches in diameter; spindle to have traverse of 18 inches to 36 inches; to have eight changes of speed in either direction, and four instantly changeable automatic feeds; automatic feeds as well as slow and rapid hand movements of spindle to be controlled from position most convenient to workman, and to be operated with equal facility from either side of machine; revolving sleeves surrounding spindle to have face plate to which head for facing may be attached; main table to be raised and lowered by means of connected screws and gearing, and to support saddle with transverse table having movements at right angles by screws; outer end of boring bar to be supported by adjustable yoke, which will also afford additional stiffness to table.

One 12-inch shaping machine; cutting bar to have at least four speeds and quick return motion; stroke to be 12 inches with adjustment for any position and length of movement; tool slide to swivel to any angle from vertical to horizontal and to

have movement of 6 inches; to have positive feed variable and self-acting in either direction; saddle carrying cutting bar to have clamping vise, pair of centers, self-feeding cone-arbor, countershaft and wrenches.

FOUR ROUGHING LATHES AND TWO FINISHING LATHES FOR SPECIMENS.

To be plain, back-geared, heavily built lathes without screw-cutting gear; to swing 12 inches and take 18 inches between centers.

Three lathes for armor bolts; to be specially made and very heavy; one to have 25-foot bed, one 12-foot bed, and one 9-foot bed; all to swing 27 inches; one of the lathes to be supplied with two extra lead screws for 3 and $3\frac{1}{2}$ threads to the inch.

One lathe to swing 24 inches and take 12 feet between centers.

Two lathes to swing 16 inches and take 10 feet between centers.

Two lathes to swing 12 inches and take 6 feet between centers.

All of the above lathes to be first-class modern tools; all to have taper attachment and screws for screw-cutting; lead screws to be used only for screw-cutting; to have compound slide rest with power cross feed.

One 10-inch slotting machine; cutting bar to have 4 speeds with counterbalance, quick return motion and relief tool apron; stroke to be 10 inches with adjustment for any position and length of movement; feeds to be positive by variable cam self-acting in all directions and operating at upper end of stroke; distance from front of cutting bar to inside of frame, 20 inches; compound tables to have an adjustment 17 inches longitudinally and 24 inches transversely, and to support revolving table 24 inches in diameter, which may be fixed in position by corner clamps when circular feeds are not in use. Tool closet in frame; countershaft and wrenches to be included.

One 30-inch slotting machine; stroke to be 30 inches, with adjustment for any position and length of movement; cutting bar to have 10 speeds, with counterbalance, quick return motion, and tool relief apron, which may be made automatic if so ordered; to be provided with reinforcing guide vertically, which may be adjustable vertically to suit work; feeds to be positive by variable cam self-acting in all directions, operating at upper end of stroke, and so arranged that all may be controlled by workman from one position. Distance from front of cutting bar to inside of frame, about 47 inches; compound tables to have an adjustment of 66 inches longitudinally and 60 inches transversely, and to support a revolving rectangular table 54 inches diameter, or 68 inches across the corners, which may be fixed in position by corner clamps when circular feeds are not in use; countershaft and wrenches to be included.

Two emery grinders, for grinding tools; wheels about 15 inches diameter and 2-inch face.

Two 36-inch drill presses, to have circular table 26 inches diameter, carried on swinging bracket; table to be raised and lowered by power; travel, 30 inches; diameter of steel spindle to be at least $2\frac{1}{16}$ inches, stroke 12 inches; to have automatic power feed, adjustable instantly and through great range. All necessary operating tools to be furnished.

ONE UNIVERSAL MILLING MACHINE.

Table to have automatic longitudinal feed of 17 inches; transverse movement of 6 inches, and to be capable of being lowered 17 inches from center of spindle; the centers to swing 8 inches in diameter and take 14 inches in length. Cone to have 4 steps. Table to be 28 inches long, 5 inches wide, and to be slotted for securing work; to have six changes of feed varying from 0.006 to 0.055 inch to one revolution of spindle. Adjustable dials graduated to read to thousandths of an inch to indicate the transverse and vertical movements of table. To have change gear, index plates, and table explaining the use of same; 6-inch 3-jaw chuck, center rest, raising blocks, wrenches, and everything else necessary for complete operation of machine.

TWO UNIVERSAL MILLING MACHINES.

With tables having longitudinal feed of $20\frac{1}{2}$ inches; transverse movement $6\frac{1}{2}$ inches, and table to be lowered $17\frac{1}{2}$ inches from center of spindle. Centers to swing 10 inches in diameter and take 15 inches in length. Cone to have 3 steps and to be back geared, giving 6 changes of speed.

Overhanging arm to be so fitted that it can be removed or turned out of the way, and to have adjustable center; distance from center of spindle to arm, $5\frac{1}{2}$ inches; greatest distance from end of spindle to center of arm, 14 inches. The feed of the table to be automatic in either direction, and to be changed by a sim-

ple movement of lever on front of saddle. To have twelve changes of feed, varying from 0.005 to 0.147 inch to one revolution of spindle. Adjustable dials, graduated to read to thousandth of an inch, to indicate the transverse and vertical movements of table. The vise to swivel and to have graduated piece; jaws to be $5\frac{1}{8}$ inches wide, $1\frac{1}{8}$ inches deep, and to open $2\frac{3}{4}$ inches. Machine to be furnished with change gears, index plates, and table explaining use of same, 6-inch three-jaw chuck, collets, center rest, raising blocks, wrenches, and everything else necessary for complete operation of machine.

ONE COMBINED PUNCH AND SHEARS.

To be at least 20 inches in throat, and to punch holes up to 1 inch in diameter and shear steel plates five-eighths inch in thickness. To be a very heavy modern tool, complete in all respects, and driven by electric motor which will be directly attached to machine.

ONE PATTERN MAKER'S WOOD-TURNING LATHE.

To swing 24 inches over shears and take 10 feet between centers. To have back face plate and floor rest. To be a modern tool, heavily made, and furnished with all necessary tools, cutters, wrenches, and appliances for its complete operation.

ONE PATTERN MAKER'S WOOD-TURNING LATHE.

Similar to the above, except that it shall take 6 feet between centers and swing 16 inches over shears.

TWO BAND SAWS.

Wheels to be of iron, 36 inches in diameter, and have rubber tires to give elasticity and increased cohesion. Wheel shafts to be run in self-oiling boxes hung on pivots and to have hand screws by which they may be easily tilted to change track of saw blade. Tension of saw to be regulated by upper wheel, which is to be hung in gibbed frame and to be quickly adjusted by means of large handwheel. Guides to be of improved design, upper one to adjust 13 inches above table and to be provided with compensating balanced weight hung inside of column.

Table to be of wood glued up in narrow strips to prevent warping and to have an adjustment for bevel sawing. Each of the above to be furnished with two saws, one 1 inch and one three-fourths inch in width.

ONE DANIELS PLANER.

To plane 12 feet long, 16 inches wide, and 8 inches thick. To be furnished complete, with all cutters, tools, etc., necessary for its operation. Lumber to be held by screw clamps which can be quickly changed for pieces of any size within the capacity of the machine.

ONE 24-INCH DOUBLE-GEAR PLANER.

Feed rolls to be driven; to have two changes of feed; to plane 24 inches wide and from one-sixteenth of an inch to 7 inches in thickness; cutter heads to be of forged steel; journals to be 8 inches long, driven by two belts. To have two pressure bars, the receiving one weighted and to swing clear of knives.

ONE 18-INCH CIRCULAR RIPSAW AND TABLE.

Sides of table to be mounted on heavy base plate, which also carries countershaft and swinging arm. The arm to be of ample length, one end mounted on gudgeons, through which countershaft passes, the other end, carrying the saw and mandrel, to be raised or lowered to any desired height while machine is in motion by turning wheels at end of machine. Table to be 38 inches wide and 5 feet long, planed true on top and provided with bevel and square cut-off and ripping gauges; also with loose piece that can be removed to admit the use of heads 3 inches thick or less for cornering, rabbeting, gaining, etc. To be furnished with all tools, gauges, etc., necessary for its operation.

ONE 12-INCH RIP AND CROSSCUT SAW AND TABLE.

To have 2 saws, each 12 inches in diameter, one for ripping and one for crosscutting. The mandrels to be mounted in revolving frames, which in moving around bring either the rip or crosscut saw into use, as may be desired. Frame to be revolved by means of handwheels.

Table to consist of two parts. The table on right of saw to be fixed to main frame and have fitted in top a very accurate adjustable gauge, moved approximately to any position by hand and then clamped to a slide, which is then moved by screws for close and accurate setting. Table on the left of the saw to slide easily on carefully fitted ways. To have an adjustable gauge, with index to set it at all angles. All necessary tools and appliances for properly operating this machine to be furnished.

ONE GLUE HEATER.

To take 3 pots, one of 1 gallon and two of one-third gallon each.

TWO JIG SAWS.

Each will have 18-inch saw; one will have a stationary table and one a tilting table; both will have air pump and all appliances for a first-class tool.

SIX WORKBENCHES.

The workbenches will be ordinary carpenter's benches, each with vise attached.

SPECIFICATIONS FOR POWER PLANT.

STEAM ENGINES.

The generators for supplying current to the various motors operating the cranes and tools and for the arc and incandescent lights will be driven by vertical, triple-expansion engines coupled directly to the armature shaft. The axes of the cylinders will be in the same vertical plane and each cylinder will be connected with a separate crank. The cut-off will be variable on the high-pressure cylinder and will be controlled by a governor revolving with the shaft. The cut-off on the intermediate and low pressure cylinders will be fixed. The high and intermediate pressure cylinders will have piston valves and the low-pressure one slide valves. If preferred a quadruple-expansion engine may be used, in which case the high and first intermediate pressure cylinders will be placed as closely together as possible with the cranks 180 degrees apart, and the pistons and other running parts of the two cylinders must be of the same weight. The same requirements will apply to the second intermediate and low pressure cylinders, and their cranks will be set at 90 degrees with the high and first intermediate pressure ones. The high and first intermediate pressure cylinders will have piston valves and the second intermediate and low pressure slides.

Whatever style of engine is employed must be of thoroughly modern design, with large bearing surfaces and automatic oiling devices. The cylinders, steam chests, and pipes must be well clothed with nonconducting material over which Russia iron will be secured. The bedplates will be very heavy and the engine columns will be of forged steel. The engine foundation will be so designed that all the oil running from the engine may be caught and pumped through a filter and used over. All steam chests will have liners or removable seats for the valves.

There will be a complete set of brasses furnished with each engine for spare; these brasses must be fitted in place before delivery. All necessary wrenches, gauges, etc., will also be furnished. Striking points will be marked on the slides and center marks on the shaft. Piston rods and valve stems will be packed with metallic packing.

The engines must run, at the full power of the generators and at full speed, without heating, jarring, or vibration.

The steam pressure to be carried will be 160 pounds per square inch and the engines will be run condensing.

It is intended that the engines shall run at 120 revolutions per minute, and the variation in speed, for any change of load or steam pressure, must not exceed 1 per cent.

There will be a surface condenser with independent air and circulating pumps and of sufficient capacity to condense the steam from the engines driving the generators and the pumps for the forging and bending presses.

The necessary galleries and ladders will be erected around the engines to render the top of the cylinders readily accessible.

ELECTRIC GENERATORS.

To be of the direct-current, constant-potential type, each having a capacity of 200 kilowatts at 115 volts, to run at 120 revolutions per minute. The fields to be multipolar, top half of frame to be removable. Field windings to be compound.

Series windings to be fitted with an adjustable shunt to vary the compounding from 0 to 10 per cent over compound. The armatures to be of the ironclad type, the core to be well laminated. The material comprising the magnetic circuit must have the highest magnetic permeability. The armature must be well ventilated. The insulation must have high spark-resisting properties, combined with strength and durability. The armatures must be well balanced and run true. The brushes must have large bearing surfaces (not over 25 amperes per square inch of contact surface). The commutator must be large, giving a small difference of potential between the bars. There must be no sparking on any load or any change of load, the brushes remaining fixed. The generators must be capable of running for a period of twelve hours on full load without producing a rise of temperature of more than 70° F. above the surrounding atmosphere in either the armature or field coils. The efficiency of the dynamo must be at least 95 per cent on full load. The insulation resistance between the frame must be at least 1 megohm.

Each generating set must be capable of carrying an overload of 50 per cent for a period of one hour without injury.

SWITCH BOARD.

To be of the panel type, made of slate, with a black enamel or black marble finish. To have one panel for each dynamo, one totalizing panel, and a suitable number of feeder panels to carry the feeders as installed. Each machine panel to be fitted with a suitable ammeter, machine switch, rheostat handle, and dial, and single pole circuit breaker. The totalizing panel to be fitted with a recording wattmeter. The feeder panels to be fitted with feeder switches and automatic shunt for each feeder, and an ammeter with a point switch connected to the various shunts. There shall also be mounted on the board a pair of differential galvanometers with suitable point switches, a ground detector with switch, one recording voltmeter, and two pressure indicators. All connections to be on the back of the boards and all instruments and switches to be mounted on the board as a base. The bus bars to be of copper of at least 98 per cent conductivity, and of cross sectional area of 1 square inch for each 1,000 amperes current. The board to be mounted in a suitable frame of angle and T iron, carried on ornamental pedestals, and inclosed in a cast brass molding with ornamental corner pieces. The board to be suitably lighted by incandescent lamps carried in brackets. The best instruments, switches, and appliances to be used throughout, and all parts must have the highest finish.

Besides the above the contractor is also to furnish all the motors required to operate the tools in the various shops. The exact number and power of each can not be given until bids from the tool makers have been received, but the aggregate will be about 25 motors with a total indicated horsepower of 600. All of these motors must be capable of running at least two speeds, and several of them must run at four speeds.

GENERAL DESCRIPTION OF AND THE NUMBER AND CHARACTER OF THE FURNACES, PRESSES, CRANES, POWER TOOLS, AND OTHER APPLIANCES REQUIRED FOR THE PROPOSED ARMOR FACTORY.

The following specifications are intended to describe the general character of the furnaces, presses, cranes, machine tools, and all other appliances and accessories required for a first-class modern armor factory of a yearly capacity of 6,000 tons of nickel steel, face-hardened, reforged armor plate.

The descriptions for tools have purposely been made so general that it is believed that no large machine-tool manufacturer will find any difficulty in producing the tool desired without infringing on any patent or proprietary right. All the larger tools must be made extremely heavy, and, other things being equal, the heaviest tool will have preference.

Bids for tools, to be considered, must be accompanied by full descriptions of the tool proposed to be furnished and drawings or blue prints showing dimensions of all principal parts, the weight of the tool, and the power required to operate it.

OPEN-HEARTH DEPARTMENT.

There will be four Wellman tilting, open-hearth, basic furnaces, with regenerators and gas producers, arranged as shown on the plans, and operated by hydraulic power. Two of these furnaces will have a capacity of 40 tons each, one of them a capacity of 30 tons, and one a capacity of 20 tons. These furnaces are to be so fitted that either oil or producer gas may be used as fuel. Each furnace is to have a separate smoke pipe.

The regenerators are to be located under the gallery and clear of the furnaces, so that no part of the weight of the latter will come on them.

The producers are to be located outside of the main building and directly opposite the furnaces.

There will also be a heating furnace, with regenerators, arranged as shown, with hearth 8 by 12 feet.

Along the fronts of the furnaces there will be a charging gallery with tracks upon which the cars carrying the charging boxes and the charging machine will run. The car tracks will lead down from the gallery by an incline and will be continued along in front of the metal magazines or storehouses. The boxes are to be there handled by a 5-ton electric crane, fitted to discharge from a standard gauge car into the magazine, and from the magazine on the cars conveying the charging boxes.

On the crane way over the fronts of the furnaces there will be a 20-ton electric crane, with sufficient travel of bridge and trolley to command the furnace fronts, the tops of the air and gas inlets to the furnaces, and the charging machine. The speed of travel of the crane will be 250 feet per minute, of the trolley 100 feet, and of the hoist 20 feet.

On the crane way in the rear of the furnaces there will be three electric cranes to command the ladles, the casting pit, and the railroad track. One of these cranes is to be of 160 tons capacity and to have a speed of travel of 150 feet per minute, speed of trolley 100 feet, and of hoist 8 feet. The other two cranes are to be of 75 and 50 tons capacity, respectively, and to have speed of travel of 150 feet per minute, of trolley 100 feet, and hoist 10 feet. All the operations of all the cranes are to be by electricity and the hoisting gear is to be so arranged that the hoist will be vertical through its entire range.

The charging machine is to be driven by electricity and is to have sufficient power to pick up a box from the car, project it into the furnace, revolve the box and empty its contents, and then return the box to the car. The machine is to be self-propelling and to have all operating gear so arranged that one man can easily control all its motions without changing his position.

There will be two cupolas for melting cast iron. One will be 5 feet internal diameter and the other 3 feet, and they will be fitted with the necessary blowers, elevators, ladles, and other foundry appliances.

There will be two core ovens, one 7 by 12 feet and the other 12 by 24 feet, internal dimensions.

There will be a casting pit extending in front of and beyond the furnaces. This pit will be 20 feet wide and 20 feet deep for 36 feet of its length and 17 feet wide and 20 feet deep for the remainder. The sides will be of masonry. Over the pit will be a track for the trucks and cars carrying the ladles.

There will be two ladles furnished for each melting furnace. These ladles must be strongly and substantially made and each one be of sufficient size to contain the entire contents of the furnace for which it is intended. The ladles will be tapped from the bottom, and they will be fitted with truck wheels, so they can be run from the furnace spout to the top of the pit truck and be thence transported to any part of the casting pit. The ladles will also have lugs secured to them, so that if desired they can be transported by the traveling cranes.

There will be four pit trucks or cars arranged to travel on the track over the casting pit. The upper sides of these trucks will have tracks fitted to receive the ladles as they come from the furnaces.

The pumps for supplying the hydraulic power for operating the furnaces must be outside-packed, single-acting, duplex-plunger pumps. The water valves must be readily accessible, and the steam valves must be adjustable from outside the chests. Steam for these pumps will be supplied by a pipe led into the building from the boiler house.

A full supply of flasks for ingots of various shapes and sizes will be furnished.

A full supply of ladles and other foundry appliances will be furnished.

FORGING AND CEMENTING SHOP.

There will be one hydraulic forging press, fitted with at least two pressure cylinders, capable of exerting a maximum pressure of 14,000 gross tons; the vertical rise of the ram will be 10 feet, and the distance between the housings or columns 14 feet. The press will also be fitted with two side rams, each capable of exerting a pressure of 4,000 tons and having a horizontal movement of ram of 4 feet.

The pumps for this press will be driven by a vertical, simple, three-cylinder crank and fly-wheel engine placed beyond and on one side of the press, as shown

on the plan. The pumps will be worked directly from the engine by rock shafts or links, or both.

The gear for operating the press will be placed directly opposite to it on the side farthest from the engine.

On each side of the press will be a small hydraulic cylinder, in which constant pressure will be maintained by means of a special accumulator. The rams of these cylinders will be connected with the ram of the press to return it to its highest position whenever the pressure is relieved from the forging cylinders.

On each front of the press will be a crane way extending entirely across the building to the ingot-heating furnaces on each side. On each of these crane ways will be one 160-ton traveling crane fitted to raise, lower, revolve, and transport the ingots and porter bars. The span of each of these cranes will be about 47 feet; the raising and lowering will be by hydraulic power, and all other motions by electricity. The speed of the crane will be 150 feet per minute, of trolley 100 feet, and of hoist 10 feet; total amount of hoist to be 10 feet.

Hydraulic manipulators are to be fitted below the floor to move the anvil and dies back and forth as may be required.

There will be 4 regenerative furnaces for heating ingots, 2 on each side of the building and opposite to the press. The fuel will be producer gas or oil, and each pair of furnaces on the same side will be provided with a producer, placed opposite and outside the building. Each furnace will have a separate smoke pipe. Each furnace will be 16 by 16 feet by 9 feet 6 inches in height. The doors of the furnaces will be operated by hydraulic power.

There will be 4 regenerative furnaces, 2 on each side of shop, for heating plates for reforging. These furnaces will have movable or car bottoms, and are to use producer gas or oil. Each adjacent pair of furnaces will have a producer placed opposite and outside the building. Each furnace will have a separate smoke pipe. The bottoms and doors of the furnaces are to be operated by hydraulic power. A track for the car bottom will extend under each furnace and to the center of the shop.

There will be 16 regenerative cementing furnaces, 8 on each side of the building. Each furnace will have a separate smoke pipe, and each pair of adjacent furnaces will have a producer placed opposite and outside of the building. The furnaces will have car bottoms. The fuel will be producer gas or oil. Eight of these furnaces will be 30 feet in length and eight 22 feet; all of them will be 14 feet in width. There will be a track running under each furnace and to the center of the building. The car bottoms and doors will be operated by hydraulic power.

The pumps, except those for the forging press, will be compound, outside-packed, single-acting, duplex-plunger pumps. They must be of such pattern that the water valves will be readily accessible and the steam valves adjustable from outside. Steam for these pumps will be led from the boiler house and a separator will be placed in the pipe.

All the necessary accumulators for operating the furnace doors and bottoms, under constant pressure, will be provided, Also a full assortment of porter bars, chucks, counterweights, and forging tools.

There will be one electrically driven emery grinder for cutting the scale from the edges of plates after cementation.

There will also be two trepanning tools for cutting test specimens.

BENDING AND TEMPERING SHOP.

On the crane way of the shop will be two 75-ton electric cranes, having a speed of 150 feet per minute, of trolley of 100 feet, and of hoist 10 feet. These crane ways will extend the whole length of the building and the cranes will pass over the top of the bending press.

The building will be lighted by arc lights and will have full water supply distributed as may be necessary.

The bending press will be capable of exerting a maximum pressure of 7,500 gross tons; it will have two cylinders and the distance between the housings and between the heads will be 13 feet; the stroke of ram will be about 8 feet. It will be operated by compound, single-acting, outside-packed, duplex-plunger pumps, placed as near the press as they conveniently can be. The pumps must be so designed that the water valves are readily accessible and the steam valves adjustable from outside the chest.

The ram is to be returned to its highest position, when pressure is relieved from it, by two small cylinders whose rams are attached to its ends and in which constant pressure is maintained by a special accumulator.

The anvil is to be moved by hydraulic manipulators.

The hand gear for manipulating the press is to be placed directly opposite it and on one side.

There will be a crane way extending from each front of the press a distance of about 68 feet; they will be the width of the press, and on each of them will be a traveling crane of 75 gross tons capacity for raising, lowering, revolving, and transporting the plate to be bent. The raising and lowering will be by hydraulic power; all other manipulations by electricity. The speed of travel will be 150 feet per minute, of trolley 100 feet, and of hoist 10 feet. Amount of hoist, 8 feet.

There will be four regenerative heating furnaces, all on the same side of the building and as near the press as they can be conveniently placed. They are to be 27 feet in length, 12 feet wide, and 12 feet in height. They are to have car bottoms and lifting doors at the end, to be operated by hydraulic power. The fuel will be producer gas or oil, and the producers will be placed opposite and outside the building. Each furnace will have a separate smoke pipe.

A car track will extend from under each furnace to the center of the building, so the car bottom of each furnace can be run directly under the press cranes.

There will be three furnaces with removable tops and ends for heating plates for tempering. All of these furnaces will be 27 feet in length and 12 feet in height; two will be 9 feet in width and the other 14 feet. They are to be fired along the sides, and the fuel will be wood or coal.

There will be a spraying apparatus by which a large number of jets of filtered ice-cold water may be driven against the cemented side of a plate and water of normal temperature on the other side at the same time. The apparatus will consist of pumps, ice tank, supports for the plates, and the necessary perforated piping above and below the supports. The upper piping will be arranged with flexible joints, so that it can be swung in any direction.

There will also be an oil tank, about 30 feet in diameter and 15 feet deep, sunk below the floor, for oil tempering. There will be a tank of the same dimensions placed outside the building, with facilities for cooling the oil.

There will be the necessary pumps and accumulators for operating the doors and car bottoms of the furnaces, the anvil of the press, and the hoists of the press cranes. The pumps will be compound, single-acting, outside-packed, duplex-plunger pumps, with water valves readily accessible and steam valves adjustable from the outside.

There will also be an annealing pit, about 20 by 30 feet and 15 feet in depth.

A full supply of shop appliances and accessories, as anvils and blocks, porter bars, slings, etc., will be furnished.

MACHINE SHOP.

The shop is to be lighted by arc lights and incandescent portables. It will be thoroughly heated by taking fresh air from the outside, passing it around a steam coil by a blower, and then distributing it through the building.

All the large tools are to be arranged on one side of the shop, leaving ample space on the other side for the passage of cars or armor plates suspended from the cranes.

A standard-gauge railroad track will extend entirely through the shop, running along the side opposite to the heavy tools.

Each large machine tool is to be driven by a separate, independent electric motor. Whenever possible the motor is to be attached directly to the machine. When this can not be done, as with a machine to be driven at many different speeds, the motor will be connected to a countershaft with speed cone.

There will be a separate motor driving a main shaft for all the power tools in the tool room; and another one, driving a shaft, for all the small tools in the wing, including the armor-bolt lathes.

There will be a fully equipped tool room located in one of the wings. It will contain two 16-inch screw-cutting lathes of the very latest design and having all improvements, such as hollow spindle, taper attachment, adjustable bearings, etc., a milling machine, a shaper, a slotter, and a drill press. There will also be a workbench with vises, racks for the tools, lockers for stores, and a desk.

There will be a full water supply distributed as may be needed.

The shop is to be supplied with the following tools:

Two universal boring, drilling, and milling machines.

Three open-side planers.

Two pit planers.

One cutting-off planer.

Two post planers.

One platen planer 12 feet wide between uprights.

One platen planer 6 feet between uprights.
Four universal drilling machines.
Two radial drills.
Two circular planers.
One lathe to swing 72 inches and take 50 feet between centers.
One lathe to swing 48 inches and take 20 feet between centers.
Two emery grinders.
One trepanning tool.
Besides the heavy tools specified above the following are required for repairs, making armor bolts, nuts, etc.:
Four roughing lathes for specimens.
Two finishing lathes for specimens, back geared.
Both the above to be about 12-inch swing and take 18 inches between centers.
Three lathes for armor bolts.
One lathe 24 inches by 12 feet.
Two lathes 16 inches by 10 feet.
Two lathes 12 inches by 6 feet.
All the above lathes to be first class, modern, screw cutting, with taper attachment.
One planer to take 20 by 20 inches by 4 feet.
Two milling machines.
One shaper 18-inch stroke, 6 feet traverse.
One shaper 12-inch stroke, 14-inch traverse.
One slotter 30 inches stroke.
One slotter 10 inches stroke.
One horizontal boring mill.
Two emery tool grinders.
Two drill presses.
One test cutter.
There will also be the necessary shafting, hangers, blocks and falls, hydraulic jacks, and hand tools of all descriptions.

ERECTING SHOP.

It is to have a crane way extending the whole length of the building. On this crane way is to be an electric crane of 75 tons capacity, having speed of travel of 250 feet per minute, of trolley 100 feet, and of hoist 10 feet. The trolley is to have a second hoist fitted with a capacity of 15 tons and speed of 25 feet per minute.

A standard-gauge railroad track will extend through the building close to one side.

The floor of the shop is to be made of heavy sleepers bedded in rubble; on the sleepers will be secured heavy planks or baulks, on which the armor plates may be set on edge.

Electric portable grinders will be supplied for truing the edges and butts of plates.

The shop will be lighted by arc lights.

A large number of slings, jacks, clamps, blocks, etc., is to be supplied.

BOILER HOUSE.

There will be sixteen boilers, each of 250 horsepower, arranged as shown.

The furnaces will be supplied by mechanical stokers and have coal boxes and chutes arranged along their fronts. A railroad track is to run above the boxes, so they can be filled directly from a car.

The boilers are to be of the water-tube type. They are to be constructed of straight tubes expanded into headers, which in turn are connected with steam and water drums. The headers must be forged, not cast.

The tubes immediately over the fire must not be less than 4 inches in diameter and at least No. 6 BWG. in thickness. If smaller tubes are used in upper courses they must not be less than 2 inches in diameter and No. 8 BWG. in thickness. No screw joints will be allowed in fire or heating spaces.

The design of the boilers must be such as to insure perfect water circulation and allow the easy and quick removal and replacing of any tube.

Each boiler will be fitted with a spring safety valve, a stop valve, a feed-check valve, a blow-off valve, three gauge cocks, a glass water gauge (the latter to show an exposed length of 24 inches), and a steam-pressure gauge. The boilers must be designed for a working pressure of 200 pounds per square inch above the atmosphere.

There will be two feed pumps, each of which is to be capable of supplying all the boilers when worked to their full capacity. The pumps are to be compound, outside-packed, single-acting, duplex-plunger pumps. The water valves must be adapted for hot water, and must be readily accessible, and the steam valves must be adjustable from outside the chest.

There will be a feed-water heater through which the water will pass on its way from the pump to the boiler. The heating will be by live steam, and the water of condensation will be fed into the suction side of the pump.

Ample provision must be made for the expansion of the steam pipes from the various boilers by slip joints and long easy bends.

There will be two smoke pipes, one on each side of the building. The inlets to the main duct must be in the direction of the draft, so that one or more boilers may not shut off another.

POWER PLANT.

It will be lighted by arc lights, and will be fitted up with desk, workbench, 5-ton traveling crane, and all the gauges, meters, and other appliances necessary in a plant of this description.

Each generating set is to consist of two multipolar electric generators of 200 K. W. capacity each, directly connected to a vertical, automatically governed triple or quadruple expansion engine. At least three sets will be required.

Whatever style of engine is used must be of thoroughly modern design, with large bearing surfaces, automatic oiling gear, forged-steel columns, and all pins, keys, nuts, etc., readily accessible and secured against working loose. The engines and generators must run at full speed and output without heating, jar, or vibration. The high and first intermediate pressure cylinders will have piston valves; the other cylinders will have slide valves. Each cylinder will have a separate crank The cut-off of the high-pressure cylinder will be variable and will be controlled by a governor revolving with the shaft. The cut-off on the other cylinders will be fixed.

The generators to be of the direct current, constant potential type, each having a capacity of 200 K. W. at 115 volts running at 120 revolutions per minute.

(NOTE.—As electricity is to be used for both light and power, it may be necessary to provide generators of different potential.)

All the motors for operating the machines and portable tools are also to be furnished.

BLACKSMITH SHOP.

It will contain:

Ten smith's forges; sides to be of iron or brick; hearth to be of fire brick slightly depressed in center; tuyere to be in center. Each forge to have smoke hood suspended over it.

One steam hammer of 3,500 pounds weight, with special furnace and jib crane.

One steam hammer of 2,000 pounds weight, with special furnace and jib crane.

One steam hammer of 1,000 pounds and one of 500 pounds, each with special fires.

One press and two furnaces for making armor-bolt washers. Form of washers may be seen at the Department.

One combined punch and shears, to be driven by an electric motor attached to the machine.

One pressure blower, driven by an electric motor directly attached, of sufficient capacity to supply all the fires at the same time. Air pressure required, 8 inches of water.

The shop to be lighted by arc lights, and a railroad track will run through on one side.

There will be an ample water supply distributed where required.

There will also be a full supply of appliances, such as anvils, swage blocks, sledges, hammers, and smith's tools of all descriptions.

A rack for bar iron and steel will be fitted on one side of the shop.

CARPENTER SHOP.

It will contain the following tools·

Two wood lathes.
Two band saws.
Two jig saws.
Two planing machines.
Two circular saws.

One glue stand.
Six workbenches and vises.
The building will be properly heated and will be lighted by electric lights.
All the above tools to be operated by electric motor.

LOCOMOTIVE HOUSE.

It will have a space for eight locomotives, with pits and drainage as shown.
It will be lighted by arc lights.
Sockets will also be provided for a number of portable incandescent lights, for use in making slight repairs and adjustments to the locomotives.

PHYSICAL AND CHEMICAL LABORATORY.

The portion intended for a physical laboratory will contain testing machines for specimens in compression, tension, and bending; a small lathe; a milling machine; a small planing machine; a drill press, and, in short, every convenience for preparing and testing such specimens of the armor plate in its various stages and manufacture as may be required.

There will be workbenches, tables, desks, lockers, and storerooms for the safekeeping of specimens and material.

The building will be lighted by arc and incandescent lights, and will be heated by steam. It will be located near the office building, and will be separated from the chemical laboratory, as shown on the plans.

That portion of the building designed for use as a chemical laboratory will be fitted up for and contain all the fittings and appliances of a thoroughly modern, first-class, well-equipped chemical laboratory, including furnaces, retorts, balances, tables, desks, lockers, etc.; in short, every requisite necessary for making rapid and accurate analyses of all substances entering into the construction of nickel-steel armor plate.

Two rooms of this building will be fitted for analyses by the micro-photographic process.

The building will be heated by steam and will be thoroughly well ventilated and lighted by incandescent lights.

OFFICE BUILDING.

On the first floor will be eight office rooms, together with a wash room, closets, etc. On the second floor will be drawing room, blue-print room, photographic room, and storeroom, together with wash room, closets, etc.

The building will be lighted by incandescent lights, both fixed and portable. It will be heated by steam.

A full supply of office furniture, such as desks, chairs, tables, etc., must be furnished, together with drawing boards, tables, blue-print frames, etc.

All the windows must be furnished with shades.

APPENDIX C.

DETAILS OF ESTIMATED COST OF PROPOSED GOVERNMENT ARMOR FACTORY.

Open-hearth department.

Buildings:		
Ironwork in trusses, columns, etc., main building	$43,017.30	
Ironwork in crane girders, main building	24,049.90	
Ironwork in platform, main building	18,692.00	
Ironwork in pit, main building	15,811.00	
Ironwork in stock house	4,934.10	
Ironwork in producer building	10,247.65	
Excavating for piers and end walls, main building	480.00	
Excavating for pit and platform, main building	1,624.80	
Excavating for stock house	16.40	
Excavating for producer-building piers	18.00	
Stonework for piers and end walls, main building	14,700.00	
Stonework for pit and platform foundation	21,441.00	
Stonework for stock house	504.00	
Stonework for producer house	630.00	
Brickwork in sides and ends, main building	9,468.10	
Brickwork in pit and platform foundation	577.05	
Brickwork in stock house	2,837.00	
Brickwork in producer building	867.50	
Woodwork in main building	11,659.00	
Woodwork in stock house	2,185.30	
Woodwork in producer house	2,810.00	
Office and fixtures in main building	1,127.00	
Slate laid, including copper nails, main building	5,763.00	
Slate laid, including copper nails, stock house	1,542.45	
Slate laid, including copper nails, producer house	847.50	
		$195,850.05
Furnaces and stacks:		
Excavating for furnaces and stacks	920.00	
Excavating for producers	912.00	
Concrete for furnaces and stacks	1,730.00	
Concrete for producers	3,260.00	
Stonework for furnaces and stacks	4,550.00	
Brickwork in gas mains	3,764.00	
Open-hearth furnaces and stacks	137,912.70	
Gas producers	16,000.00	
		169,048.70
Machinery:		
Open-hearth ladles and transfer trucks	9,619.60	
Open-hearth slag ladles	1,200.00	
Open-hearth pit and platform tools	3,880.00	
Open-hearth ingot molds and flasks	17,500.00	
Open-hearth ingot cars	6,140.00	
Open-hearth charging machine	7,800.00	
Open-hearth charging cars, 12 sets	5,500.00	
Open-hearth cranes	63,850.00	
Open-hearth scales	727.00	
Excavating for machinery	6.00	
Brickwork for machinery	80.00	
Woodwork for machinery	40.00	
Excavating for foundry machinery	78.20	
Stonework for foundry machinery	175.00	
Brickwork for foundry machinery	1,049.85	
Ladles, cupolas, core ovens, and tools	4,517.00	
Foundry flasks	2,000.00	
Foundry scales	556.00	
Foundry crane	15,200.00	
Foundry pit casings	512.00	

Machinery—Continued.		
Stock-house crane	$6,350.00	
Producer tools	100.00	
		$146,880.65
Erecting and engineering expenses		25,590.00
		537,369.40

Open-hearth storehouse.

Building:		
Iron in trusses, columns, etc	51.80	
Excavating for foundations	9.00	
Stonework in foundations	99.00	
Brickwork in sides and ends of building	370.00	
Woodwork in entire building	215.70	
Granolithic floor	180.00	
Slate laid, copper nails included	107.35	
		1,032.85
Oil tank:		
Excavating for tank foundation	10.00	
Brickwork for tank foundation	120.00	
Tank	280.00	
		410.00
Scales		130.80
Erecting and engineering expenses		75.00
Miscellaneous tools, such as jacks, blocks and falls, crabs, sling chains, vises, hammers, files, shear poles, etc		2,900.00
		4,548.65

Forge and cementing department.

Buildings:		
Ironwork in trusses, columns, etc	75,857.42	
Ironwork in crane girders	24,272.74	
Excavating for piers and end walls	398.60	
Stonework for piers and end walls	8,400.00	
Brickwork for piers and end walls	14,900.48	
Woodwork for entire building	14,113.50	
Slate laid, including copper nails	8,588.00	
Producer house complete	15,600.00	
		162,130.74
Heating, reheating, and cementing furnaces:		
Excavating for heating furnaces and stacks	644.00	
Excavating for reheating and cementing furnaces and stacks	2,928.80	
Excavating for gas producers	3,220.40	
Stonework for heating furnaces and stacks	9,058.00	
Stonework for reheating and cementing furnaces and stacks	12,600.00	
Stonework for gas-producer pits	12,376.00	
Concrete for heating furnaces	1,000.00	
Concrete for reheating and cementing furnaces	5,040.00	
Heating furnaces and stacks	55,360.00	
Reheating and cementing furnaces and stacks	303,674.00	
Gas producers and mains	29,918.00	
		435,819.20
Machinery:		
Excavating for foundations	743.00	
Stonework for foundations	17,458.00	
Brickwork for foundations	1,950.00	
Forging press, press cranes, and press pumps	760,987.00	
Pressure and general supply pumps and accumulators	49,300.00	
Traveling cranes	44,900.00	
Steam, water, and hydraulic pipes, tank, etc	10,250.00	
		885,588.00
Office and fixtures		500.00
Erecting and engineering expenses		74,200.00
		1,558,237.94

Bending and tempering department.

Buildings:		
Ironwork in trusses, columns, etc	$33,269.75	
Ironwork in crane girders	11,962.10	
Excavating for piers and end walls	194.20	
Stonework for piers and end walls	3,108.00	
Brickwork in ends and sides of buildings	9,164.40	
Woodwork in entire building	8,680.80	
Slate laid with copper nails	4,915.50	
Producer house	3,900.00	
		$75,194.75
Heating and tempering furnaces, etc.:		
Excavating for furnaces and stacks	970.40	
Excavating for producers	801.20	
Stonework in producer pits	4,900.00	
Stonework for stack foundations	2,520.00	
Stonework for tempering furnaces	2,541.00	
Heating and tempering furnaces	65,318.00	
Stacks	12,316.00	
Gas producers	6,734.00	
		96,100.60
Machinery:		
Excavating for foundations	201.40	
Stonework for foundations	3,311.00	
Brickwork for foundations	315.60	
Bending press and cranes	161,000.00	
Traveling cranes	36,500.00	
Pumps and accumulators	45,040.00	
Piping	272.45	
		246,640.45
Tempering tanks, etc.:		
Excavating for oil supply and ice tanks	289.80	
Stonework for oil supply and ice tanks	2,989.00	
Tanks and ice-water spray	3,274.30	
		6,553.10
Office and fixtures		300.00
Erecting and engineering expenses		21,250.00
		446,038.90

Machine shop.

Buildings:		
Ironwork in trusses, columns, etc	58,899.82	
Ironwork in crane girders	15,348.30	
Excavating for piers and end walls	247.40	
Stonework for piers and end walls	4,480.00	
Brickwork for side and end walls	12,442.64	
Woodwork in entire building	24,744.19	
Slate laid, including copper nails	10,115.00	
		126,277.35
Machinery:		
Excavating for machine foundations	946.60	
Concrete for machine foundations	20,186.00	
Brickwork for machine foundations	3,300.00	
Cranes with supplemental hoists	46,400.00	
Large tools in center of shop	350,800.00	
Tools in wings, including shafting, pulleys, etc	18,925.00	
Small tools, taps, gauges, etc	2,716,38	
		443,273.98
Office and fixtures		300.00
Steam heating		2,200.00
Erecting and engineering expenses		28,600.00
		600,651.33

Erecting shop.

Buildings:		
Ironwork in trusses, columns, etc		$22,215.88
Ironwork in girders		5,164.15
Excavating for piers and end walls		98.00
Stonework for piers and end walls		2,751.00
Concrete under floors		7,775.00
Woodwork in entire building		17,145.75
Brickwork in end and side walls		6,895.00
Slate laid, including copper nails		3,717.00
		$65,761.78
Machinery:		
Traveling crane with supplemental hoist		23,20[illegible].00
Steam heating		1,000.00
Erecting and engineering expenses		4,550.00
		94,461.78

Boiler house.

Building:		
Ironwork in trusses, columns, etc	15,207.95	
Excavating for piers and end walls	350.60	
Stonework for piers and end walls	1,078.00	
Brickwork for building and boiler flues	8,965.80	
Woodwork in entire building	2,850.35	
Slate laid, copper nails included	1,717.60	
		30,170.30
Boiler stacks:		
Excavating for foundations	74.00	
Masonry for foundations	2,058.00	
Brickwork	3,790.30	
Castings and foundation bolts	744.00	
Shells	5,238.00	
		11,904.30
16 batteries boilers		64,000.00
2 15 and 25 by 24 inch pumps, 9-inch plungers		7,800.00
Erecting and engineering expenses		5,700.00
		119,574.60

Power house.

Buildings:		
Ironwork in trusses and columns	15,100.00	
Excavating for piers and walls	340.00	
Stonework for piers and walls	1,050.00	
Brickwork for side and end walls	7,048.80	
Woodwork in entire building	3,100.00	
Slate laid, copper nails included	1,620.00	
		28,258.80
Machinery complete		100,000.00
Erecting and engineering expenses		6,400.00
		134,658.80

Blacksmith shop.

Buildings:		
Ironwork in trusses, columns, etc	6,317.54	
Excavating for piers and end walls	18.60	
Stonework for piers and end walls	364.00	
Brickwork for side and end walls	2,580.00	
Woodwork for entire building	2,632.50	
Slate laid, including copper nails	1,158.25	
		13,070.89
Forges and furnaces:		
Forges and piping	625.00	
Furnaces, stacks, and piping	4,200.00	
		4,825.00

Hammers and washer press:		
Foundations	$458.10	
Hammers	5,176.00	
Washer press	3,800.00	
		$9,434.10
Tools, machinery, and scales		3,532.00
Erecting and engineering expenses		1,550.00
		32,411.99

Locomotive house.

Building:		
Iron in trusses and columns	1,637.17	
Excavating	70.20	
Stonework in piers and end walls	824.00	
Drain pipe	14.40	
Brickwork in end and side walls	1,176.00	
Woodwork in entire building	1,748.36	
Slate laid, copper nails included	630.00	
Stacks	504.00	
Heating, steam	200.00	
		6,804.13
Benches, vises, and tools		75.00
Erecting and engineering expenses		340.00
		7,219.13

Carpenter shop.

Building:		
Ironwork in trusses and columns	1,643.90	
Excavating for piers and end walls	21.40	
Stonework for piers and end walls	490.00	
Brickwork in side and end walls	1,397.88	
Woodwork in entire building	1,502.20	
Slate laid, copper nails included	412.45	
		5,467.83
Machinery:		
20-horsepower motor erected	600.00	
Shafting, pulleys, etc	379.00	
Planers, lathes, saws, etc	1,260.00	
Workbenches	270.00	
Gluing outfit, clamps, etc	70.00	
Miscellaneous tools	100.00	
		2,679.00
Steam heating		120.00
Erecting and engineering expenses		420.00
		8,686.83

Offices, laboratories, etc.

Office building		15,000.00
Physical laboratory:		
Building	6,000.00	
Machinery, etc	19,000.00	
		25,000.00
Chemical laboratory:		
Building	6,000.00	
Equipment	24,000.00	
		30,000.00
Erecting and engineering expenses		3,000.00
		73,000.00

Railroad and equipment.

Rolling stock:		
2 standard-gauge locomotives, steam brakes, headlights	$14,550.00	
3 narrow-gauge locomotives, steam brakes, headlights	9,045.00	
2 locomotive cranes	16,000.00	
		$39,595.00
Railroad:		
Tracks, switches, frogs, etc	39,250.76	
Approaches to open-hearth plant, trestling, etc	4,547.00	
		43,797.76
150-ton track scale		1,050.00
Erecting and engineering expenses		2,200.00
		86,642.76

Water supply.

Standpipe:		
Excavating for foundation	40.00	
Stonework for foundation	1,120.00	
Brickwork for foundation	70.00	
Foundation bolts and washers	83.00	
Shell	5,448.00	
		6,761.00
Water pipe, valves, etc		12,937.00
Sewers		12,000.00
Erecting and engineering expenses		1,600.00
		33,298.00

Estimate on washroom and water-closets.

Brick building, slate roof, glazed ventilator, asphaltum floor, etc	2,856.00	
40 cast-iron enameled water-closets, tanks complete	1,200.00	
100 cast-iron wash basins, hot and cold water, set-over trough	1,500.00	
		5,556.00
For two houses as above		11,112.00

APPENDIX D.

List of places recommended to the armor factory board as sites for the proposed armor plant.

Name of place.	Recommended by—
The South	Hon. J. J. Johnston, governor of Alabama. Hon. G. Y. Atkinson, governor of Georgia. Hon. R. L. Taylor, governor of Tennessee. Hon. Jos. Wheeler, M. C. Hon. L. T. Livingston, M. C. Hon. John W. Gaines, M. C. Hon. R. F. Broussard, M. C. Hon. O. M. Underwood, M. C. Hon. H. Clay Evans, of Tennessee. Hon. T. C. Platt, U. S. S. Hon. W. M. Stewart, U. S. S. E. W. Cole, esq. J. J. Newman, esq.
VIRGINIA.	
Richmond	A. S. Buford, for Chamber of Commerce. W. R. Triss. A. B. Clarke. Hon. John Lamb, M. C.
Alexandria	M. B. Harlow, president Business Men's League. E. E. Downham, for Board of Trade.
Roanoke	W. E. Deaton, chairman Board of Trade. W. C. Bullitt. D. W. Flickwir. Jas. A. Miller.
Basic City	M. A. Booker.
Westpoint, 38 miles from Richmond, 100 miles from Washington, on Pamunky and Mattapony rivers.	W. R. Broaddus.
Petersburg	R. G. Gilman, secretary Chamber of Commerce.
Radford, New River Junction, 8 miles west of Roanoke.	J. G. Osborne, president Board of Trade. Geo. W. Miles.
Norfolk and Portsmouth	Hon. W. F. Young, M. C. W. B. Mayo, mayor. G. E. Borden.
Claremont, Surry County, James River	Thomas Clifford.
St. Helena, opposite Norfolk Navy-Yard	Parke L. Poindexter, Berkeley County.
Craney Island and West Norfolk	Jas. P. Wise, president The West Norfolk Improvement Co.
WEST VIRGINIA.	
Morrison Island (Piedmont), between West Virginia and Maryland.	J. P. Williams, mayor of Piedmont. S. M. Thomas. J. B. Elliott.
Westernport, part of Maryland	Jno. Gardner. M. J. Rooney. Wm. Mellor. T. P. Hillard. J. H. Fisher. Hon. S. B. Elkins. G. W. Atkinson, governor of West Virginia.
Cherry Run, Berkeley County, 13 miles northwest of Martinsburg.	Jos. P. Breen, Pittsburg, Pa.
Piedmont, North Branch Potomac River, 206 miles west of Baltimore.	J. S. Jamesson.
Grub district, Hancock County, opposite East Liverpool, Ohio.	A. J. Boyce, East Liverpool, Ohio.
Huntington	H. C. Harvey, president Chamber of Commerce.
Moundsville	G. S. McFadden. L. C. Strider.

List of places recommended to the armor factory board as sites for the proposed armor plant—Continued.

TENNESSEE.

Name of place.	Recommended by—
Harriman, on Emory River	L. S. Freeman. S. M. Felton. S. W. Williams, for Business Men's League.
Knoxville, right bank of Holston River, 180 miles east of Nashville, 112 miles northeast of Chattanooga.	Hon. H. R. Gibson, M. C. Jas. Maynard. Hon. H. L. Taylor, governor. Hon. J. W. Gaines, M. C. M. L. Ross, president Chamber of Commerce. Maj. F. K. Huger, superintendent Southern Railway. Maj. E. C. Camp. C. C. Howell. Thos. I. Stephenson. Maj. E. E. McCroskey. R. R. Strong. J. S. Van Gilder. Jno. E. Chapman.
Chattanooga, left bank of Tennessee River, 151 miles southeast of Nashville, 138 miles north-northwest of Atlanta.	M. V. Richards, land and industrial agent Southern Railway. Hon. J. W. Gaines, M. C. H. S. Chamberlain and others, for Chamber of Commerce.
Bristol, Tennessee and Virginia, on boundary line, 130 miles east-northeast of Knoxville.	J. C. Byars. C. L. Bunting, for Board of Trade. W. G. Sheen.
Elizabethton, Watauga Valley, Watauga and Doe rivers, 1,500 feet above sea, 280 miles from Charleston, S. C.	Hon. J. G. Carlisle. Hon. H. C. Hansbrough. Hon. Benj. Butterworth. Hon. J. T. DeBois.
Morristown	Mr. H. W. Coffin and the Board of Trade. B. F. Stubblefield, mayor. Hon. W. P. Brownlow, M. C.

ALABAMA.

Birmingham, 96 miles north-northwest of Montgomery.	Hon. J. J. Johnston, governor of Alabama. Hon. J. T. Morgan, U. S. S. Hon. O. W. Underwood, M. C. Hon. J. H. Bankhead, M. C. S. Spencer, president Southern Railway. Hon. T. S. Plowman, M. C. Hon. W. Brewer, M. C. Hon. G. W. Taylor, M. C. Dr. Wm. B. Phillips.
Sheffield, on Tennessee River	A. W. Wills, president Sheffield Iron and Steel Co. Hon. Jos. Wheeler, M. C. Hon. W. E. Chandler, U. S. S. Judge Thos. R. Roulhac. J. C. Foster. J. C. Harris and C. B. Ashe.
Gadsden, on Coosa River, 70 miles northeast of Birmingham.	J. M. Elliott, jr., mayor.
Anniston	Edwd. S. Tyler. F. W. Hight, mayor.
Flomaton	J. J. Sullivan, Pensacola, Fla.

KENTUCKY.

Middlesboro	C. M. Woodbury, vice-president Business Association. Hon. D. G. Colson, M. C. John Ralston. J. W. Campbell. John M. Brooks. C. W. Cantrell. John Sanderson.

List of places recommended to the armor factory board as sites for the proposed armor plant—Continued.

TEXAS.

Name of place.	Recommended by—
New Birmingham, on Rusk River, 84 miles southwest of Jefferson.	Hon. S. B. Cooper, M. C. Hon. J. H. Stephens, M. C. Hon. H. Chilton, U. S. S.
Jefferson, northeastern part of State, 162 miles east of Dallas, on branch of Red River.	W. T. Atkins, president of Jefferson Iron Co. Hon. J. H. Stephens, M. C. Hon. R. Q. Mills, U. S. S. Hon. J. L. Slayden, M. C. Hon. Rudolph Kleberg, M. C. Hon. J. W. Crawford, M. C. Hon. H. Chilton, U. S. S.
Waco, on Brazos River, 100 miles north of Anniston.	A. Hinchman, ex-mayor.

GEORGIA.

Blythe Island, near Brunswick; 60 miles south-southwest of Savannah.	Hon. W. G. Brantley, M. C.

NEW YORK.

Buffalo	J. S. Holmes Improvement Company. Hon. D. S. Alexander.
New York Harbor (near)	W. S. Fielding.

NEW JERSEY.

New Orange	C. W. Manahan, jr., and others. The New Orange Industrial Association.

MARYLAND.

Sparrows Point, on Patapsco River, near Baltimore.	F. W. Wood, president Maryland Steel Co.; officers of Pennsylvania Steel Co.
Drum Point, mouth of Patuxent River, near Baltimore.	Alex. de Barril.
Curtis Bay, 4 miles south of Baltimore, on arm of Patapsco River.	W. S. Raynor, president Curtis Bay Co.

PENNSYLVANIA.

Johnstown (Connemaugh River, 78 miles east of Pittsburg).	F. G. Dilret.
Williamsport (Susquehanna River, 20 miles northwest of Philadelphia).	J. B. Dubble, president Board of Trade.
Carroll Township, Washington County (near Monongahela City).	Jno. F. Thomas, Webster, Pa.
Rankin Station (Monongahela River, near Pittsburg).	Thos. Rankin.
Scranton	D. B. Atherton, secretary Board of Trade. Douglas Benson, secretary Board of Trade.
Erie, 28 miles southwest of Buffalo, 148 miles north of Pittsburg.	Hon. Jas. S. Butler, M. C. Mr. Fred Baldt.
Chester, Delaware River, 15 miles below Philadelphia.	E. P. Stofer, secretary for the Board of Trade.
Reading (Schuylkill River, 58 miles from Philadelphia, 126 miles from New York).	

List of places recommended to the armor factory board as sites for the proposed armor plant—Continued.

OHIO.

Name of place.	Recommended by—
Lorain, 20 miles west of Cleveland	Thos. McCann, justice of the peace.
Columbus, capital city, on Scioto River, 193 miles west of Pittsburg.	G. H. Stewart, president, and J. F. Oglevee, secretary, Board of Trade.
	Thos. Leonard (proposing sale of land).
Fairport Harbor, 28 miles east of Cleveland	E. G. Wetherbee.
Dayton, on Great Miami River and Miami Canal, 60 miles northeast of Cincinnati.	J. B. Thilman, commercial traveler.
Youngstown	C. B. Wick, secretary and treasurer, Board of Commerce.
Cleveland	Hon T. E. Burton, M. C.
	Hon. W. D. B. Alexander, chairman committee of Chamber of Commerce.
Toledo	W. H. Chase, secretary armor plate plant committee, of the Toledo Chamber of Commerce.

INDIANA.

Marion, 193 miles northeast of Indianapolis	Hon. G. W. Steele, M. C.
Michigan City	C. J. Taylor, chief deputy, Bureau Statistics.
	Hon. H. B. Tuthill.
Anderson	J. P. Sears, secretary Commercial Club.
Indianapolis	Jesse Overstreet, esq.

ILLINOIS.

Waukegan, 35 miles north of Chicago; 50 miles south of Milwaukee.	Mayor W. W. Pearce and committee of aldermen.
Moline, 4 miles above Davenport, Iowa	C. H. Pope.
Chicago	Illinois Steel Company.

WISCONSIN.

Appleton, 185 miles from Chicago; 20 miles north of Oshkosh; 6 miles north-northeast of Menasha.	Appleton Advancement Association
Menasha, 30 miles from Green Bay; on Fox River, Lake Winnebago; 14 miles north-northeast of Oshkosh.	P. V. Lawson, mayor.
	Hon. J. H. Davidson.
Kenosha, Washington Island, Lake Michigan, southeast corner, near Illinois.	Hon. E. G. Timme, auditor.
Superior	Hon. Jno. J. Jenkins, M. C.
	Hon. C. K. Davis, U. S. S.
	Hon. Page Morris, M. C.
	T. W. Hugo.
	G. W. Buck.
	T. R. Carey.
	Wm. E. Richardson.
	C. H. Sunderland.
	S. N. Brochon.
	Albert N. Seip.
	Alex. McDougal.
	J. M. Munger.
	Hon. J. C. Spooner, U. S. S.

MICHIGAN.

Muskegon, 5 miles from Lake Michigan, 120 miles northeast of Chicago.	H. Park, president, and W. D. Kelly, secretary, Chamber of Commerce.
Marquette	J. E. Sherman, mayor.
Detroit	Hon. Wm. C. Maybury, mayor.

List of places recommended to the armor factory board as sites for the proposed armor plant—Continued.

MINNESOTA.

Name of place.	Recommended by—
Duluth, 156 miles northeast of St. Paul	Hon. Lorin Fletcher, M. C. Hon. C. K. Davis, U. S. S. Hon. Page Morris, M. C. Hon. Jno. J. Jenkins, M. C. Hon. J. C. Spooner, U. S. S. T. W. Hugo. G. W. Buck. T. R. Carey. Wm. E. Richardson. C. H. Sunderland. S. N. Brochon. Albert N. Seip. Alex. McDougal. J. M. Munger.

MISSOURI.

St. James, Naramec River, 104 miles southwest of St. Louis.	Wm. James, esq.

WASHINGTON.

Seattle, Tacoma } 20 miles apart	Hon. J. H. Lewis, M. C.
Port Townsend	W. B. Dennis, president Board of Trade.

APPENDIX E.

ADVERTISEMENT FOR PROPOSALS.

UNITED STATES GOVERNMENT ARMOR FACTORY.

Proposals will be received at the Navy Department, Washington, D. C., until 12 o'clock noon, on Saturday, January 29, 1898, to be then and there publicly opened, for furnishing and constructing by contract a Government Armor Factory, including the land, buildings, and machinery, as a whole plant, or for furnishing and constructing separately the land or the buildings or the whole or any part of the machinery to be embraced in such a plant, all in accordance with the plans and specifications. A printed circular, which states more particularly what is requisite in the premises, and to the terms of which this notice is subject, may be obtained together with forms of proposals, on application to the recorder of the Armor Factory Board, at the Department. Prospective bidders should apply in person to the recorder of the board for information as to details, specifications, and plans of such a plant, and for opportunity to examine and use the same in preparing their proposals. Proposals must be made in duplicate on the Department's forms, enclosed in sealed envelopes, marked "Proposals for Armor Factory," and addressed to the Secretary of the Navy, Navy Department, Washington, D. C.
John D. Long, Secretary of the Navy.

CIRCULAR OF INSTRUCTIONS REGARDING CONSTRUCTION OF PROPOSED UNITED STATES GOVERNMENT ARMOR FACTORY.

NAVY DEPARTMENT,
Washington, D. C., December 1, 1897.

In accordance with the act of Congress approved July 19, 1897, sealed proposals are hereby invited and will be received at this Department until 12 o'clock noon, January 29, 1898, at which time and place they will be publicly opened, for the construction by contract of a Government armor factory, including the land, buildings, and machinery as a whole plant, in accordance with the plans and specifications. Proposals will also be received at the same time and place for furnishing separately the land or buildings or the whole or any part of said machinery embraced in such a plant, in accordance with the plans and specifications.

The proposed armor factory includes the following: 140 to 160 acres of land with good foundations, good drainage, good water supply, and facilities for railroad connections, and erected thereon ten one-story steel buildings with sloping roofs and brick filling between columns, as follows: One, 494 feet long by 153 feet wide, with casting pit 20 to 17 feet wide and 324 feet long; one, 833 feet long by 131 to 171 feet wide, with foundations for heavy forge press; one, 505 feet long by 130 feet wide, with foundations for heavy bending press; one, 830 feet long by 131 feet wide, with foundations for heavy machine tools; one, 305 feet long by 131 feet wide, with special ballasted floor; one, 241 feet long by 96 feet wide, with foundations for boilers and pits for stack connections; one, 200 feet long by 96 feet wide, with foundations for electric generators; one, 127 feet long by 52 feet wide, with special floor for locomotives; and four brick structures, including one office building 98 feet long by 49 feet wide; two laboratories, each 50 feet square, connected by a passage; and two latrines, each 100 feet long by 25 feet wide. Four Wellman tilting basic open-hearth furnaces, with regenerators, gas producers, and hydraulic appliances complete; two small melting cupolas, fitted with blowers, elevators, ladles, and other foundry appliances; two core ovens; eight open-hearth casting ladles; and four casting pit ladle trucks. One small and twelve large heating furnaces, with regenerators and hydraulic lifting doors; three heating furnaces for tempering, fired along the sides; sixteen regenerative car-bottom cementing furnaces, with hydraulic appliances; one special face-hardening spray apparatus, with

ice tank and pressure pumps; and two circular tanks 30 feet diameter by 15 feet deep. One electric charging machine, and twelve cast steel open-hearth charging boxes. One hydraulic forge press, 14,000 gross tons pressure, and one hydraulic bending press, 7,500 gross tons pressure, with pumps and engines, auxiliary pumps and accumulators, hydraulic anvil manipulators, anvils, blocks, porter bars, chucks, slings, counterweights and forging tools complete in each case. Two 160-ton and two 75-ton electric overhead traveling cranes, with special hydraulic lifts; one 160-ton, one 100-ton, five 75-ton, one 50-ton, one 20-ton, and one 5-ton electric overhead traveling cranes. One special portable grinder for cutting scale from plates. Two heavy universal boring, drilling, and milling machines; three heavy open side planers; two heavy pit planers; one heavy cutting-off planer; two heavy post planers; two heavy platen planers; four heavy universal drilling machines; two heavy radial drills; two heavy circular planers; two emery grinders; three trepanning tools for test specimens; eighteen lathes of varying sizes; one small planer; two small milling machines; two medium shapers; two slotters, one large and one small; one medium horizontal boring mill; two emery tool grinders; two small drill presses; one test cutter; three electric portable grinders; two testing machines, 200,000 pounds capacity each; one small test milling machine; one small planing machine, and one small drill press. Sixteen water-tube boilers, of 250 horsepower each, with feed pumps, mechanical stokers, feed-water heaters, and two stacks for the battery complete. Ten smiths' forges; one pressure blower, motor driven; four steam hammers, 3,500 to 500 pounds weight, each with special furnace and jib crane; one small forging press, one combined punch and shear, for $\frac{5}{8}$-inch plates, swages, blocks, sledges, hammers, and smiths' tools. Two wood lathes; two band saws; two jig saws; two wood-planing machines; two wood circular saws; six carpenter workbenches and vises; and one glue stand. Three sets of electric multipolar generators of 400 KW. capacity each, and each with engine complete; about twenty-five electric motors for operating tools of varying sizes; arc and incandescent lamps, and wiring for entire plant. The equipment of chemical laboratory complete with furnaces, retorts, balances, tables, etc. One complete apparatus for micro-photographic analyses. About 30,000 feet of standard-gauge railroad track; about 5,000 feet of narrow-gauge track; one standard-gauge railroad track scales, for 150 tons; two standard-gauge and three narrow-gauge locomotives; twelve steel platform cars; fifty ordinary platform cars; and twenty-five heavy hand trucks, of standard gauge; thirty-six narrow-gauge cars for charging boxes; and two locomotive track cranes, 10 tons each.

All bids must be accompanied by specifications and drawings, showing in detail the land, buildings, and machinery proposed to be furnished, together with the number and character of all accessories with each furnace, hydraulic press, and power tool. The drawings of machine tools must show all principal dimensions and give the estimated weight of each tool and the power required to operate it. The drawings for land must include profiles showing the character of soil and subsoil as ascertained by borings.

The Department presumes that, should an appropriation be made by Congress for the erection of this plant, successful bidders will be required to enter into contract and give satisfactory bond in a penal sum, either fixed by Congress, or to be fixed by the Department, for the performance thereof within the time specified in their proposals.

The bidders will distinctly understand that no such appropriation has yet been made, and that not only is the usual right reserved by the Department to reject any or all bids, but that under the statute authorizing this advertisement the Department will report to Congress the receipt of all bids made, and await its further action.

The time in which the work can be delivered or completed must be stated in the bid, and, in considering the bids, weight will be given to this statement, and also to any statement which bidders make as to the security which they will furnish for the faithful performance of any contract awarded to them.

Prospective bidders should apply in person to the recorder of the Armor Factory Board for information as to details, specifications, and plans of such a plant, and for opportunity to examine and use the same in preparing their proposals.

Proposals must be made in duplicate on the Department's forms, inclosed in sealed envelopes, marked "Proposals for Armor Factory," and addressed to the Secretary of the Navy, Navy Department, Washington, D. C.

JOHN D. LONG,
Secretary of the Navy.

APPENDIX F.

MINUTES.

NAVY DEPARTMENT,
Washington, D. C., August 9, 1897.

Board met at 10 a. m.
Present, all the members, as follows: Commodore John A. Howell, U. S. N., president; Capt. Alexander H. McCormick, U. S. N.; Civil Engineer Mordecai T. Endicott, U. S. N.; Chief Engineer James H. Perry, U. S. N.; Lieut. Frank F. Fletcher, U. S. N.; Lieut. Washington I. Chambers, U. S. N., recorder.

The precept and instructions were read. (See File F.)

At the request of Acting Secretary of the Navy, the board was received by him, from 11.15 to 11.45 a. m., during which time he gave the board his idea of the scope of the board's investigation under the orders.

The Acting Secretary was requested to furnish all information in the Department relating to the subject of armor-factory plants.

The mass of information on the subject of armor plants already printed and reports of careful investigations relating thereto were received (see File G), and copies were distributed among the members for their perusal.

A recess was then taken at 12.15 until 1.30.

AFTER RECESS.

The board reconvened at 1.30.

Letters and telegrams sent to the Carnegie and Bethlehem companies requesting permission to visit their works. (See Letter Book No. 1, pp. 2 and 4.)

After some discussion as to the requisites of an armor plant and the best plans for getting information, the board adjourned until Tuesday, August 10, at 9.30 a. m.

AUGUST 10, 1897.

The board met at 9.30 a. m.

Present, all members.

Telegrams received from Carnegie and Bethlehem companies stating they would be pleased to have the board visit their works at its convenience.

Agreed to visit the works of these companies, arriving at the works of the Bethlehem Iron Company, South Bethlehem, Pa., Monday, August 16, at 10.35 a. m.; and later to visit the works of the Carnegie Steel Company, Pittsburg, Pa.

Telegrams and letters were sent to both companies accepting their invitations.

Letters sent to inspectors requesting them to make necessary hotel arrangements.

Letters to chiefs of Ordnance, Construction and Repair, and Steam Engineering requesting that inspectors be directed to assist board on its arrival at the steel works.

Stenographer and typewriter employed. Formal contract signed. (See File B.)

Recess at 10.05 a. m. until 3 p. m.

AFTER RECESS.

The board reconvened at 3 p. m.

Agreed: That the president inform the Acting Secretary of the Navy of the plans of the board to visit the armor plants at South Bethlehem, Pa., and Pittsburg, Pa., and request his approval; also that the Acting Secretary be requested to give some idea of how much should be paid an armor expert, if employed; also that newspaper men may be informed of the plans and movements of the board, but no comparisons or expressions of opinion shall be given for publication.

The president then informed the board that he had seen the Acting Secretary, who approved of the proposed visits to South Bethlehem and Pittsburg, and the other plans of the board to date. The Acting Secretary was not prepared to say how much should be paid an expert, if employed.

After some discussion it was agreed, at 4.45 p. m., to adjourn to meet at South Bethlehem, Pa., on Monday, August 16, at 10.35 a. m., the intervening time to be

allowed to members to read the mass of information already collected on the subject of armor plants.

Communications were received and answered from the following:

Hon. George W. Steele, M. C., concerning advantages of Marion, Ind., as an armor-factory site. (File Case A.)

Mr. William T. Cunningham, of Philadelphia, Pa., concerning advantages of a site for the proposed armor factory. (File Case A.)

Mr. John Colahan, of Cleveland, Ohio, concerning the advantages of a site at Fairport Harbor, Lake County, Ohio. (File Case A.)

Mr. H. C. Harvey, president Chamber of Commerce, Huntington, W. Va., concerning advantages of that place. (File Case A.)

Hon. O. W. Underwood, M. C., concerning advantages of his district. (File Case A.)

Mr. F. W. Wood, president Maryland Steel Company, concerning advantages of a location on the Patapsco River, a few miles below Baltimore. (File Case A.)

Mr. J. H. Adams, Birmingham, Ala., concerning his capacity to furnish estimates and make drawings for an armor plant. (File Case B.)

Mr. J. E. Blackburn, Ph. G., Columbus, Ohio, concerning an improved process for the manufacture of steel. (File Case E.)

Mr. James H. Carpenter, Reading, Pa., concerning improved methods in the manufacture of steel and armor plate. (File Case E.)

Mr. C. M. Spalding, Bridgeport, Conn., offering his services as draftsman. (File Case B.)

Ensign Charles B. McVay, jr., U. S. N., concerning plans and estimates of plants around Pittsburg, Pa. (File Case C.)

Mr. C. Colne, New York City, concerning the submission of a new steel process for armor-plate manufacture. (File Case E.)

Mr. W. G. Howell, East Orange, N. J., tendering his services as expert. (File Case B.)

Mr. Frederick S. Duncan, New York City, concerning advantages of communicating with Messrs. Armstrong, Whitworth & Co., regarding bids for forging press and other heavy machinery required in the manufacture of armor plate. (File Case C.)

Hon. Loren Fletcher, M. C., requesting names of the board, and to be informed as to its exact procedure. (File Case A.)

AUGUST 11, 1897.

Letters were read and answered from the following:

Mr. W. S. Fielding, New York City, concerning a site for the proposed armor plant near New York. (File Case A.)

Hon. D. S. Alexander, M. C., concerning the adaptability of Buffalo as a site for the proposed armor plant. (File Case A.)

Mr. Joseph P. Breen, Pittsburg, Pa., concerning advantages of Cherry Run, Berkeley County, W. Va., as site for proposed armor plant. (File Case A.)

Mr. James G. Glynn, Annapolis, Md., tendering his services as stenographer and typewriter. (File Case B.)

AUGUST 12, 1897.

Letters were read and answered from the following:

Mr. Thomas Rankin, Rankin Station, Pa., concerning a site on the Monongahela River for proposed armor plant. (File Case A.)

Mr. Theodore Leonard, Columbus, Ohio, concerning advantages of certain land at Columbus, Ohio, for proposed armor plant. (File Case A.)

Mr. D. B. Atherton, secretary Scranton Board of Trade, concerning advantages of Scranton, Pa., as a site for proposed armor plant. (File Case A.)

Mr. Thomas McCann, justice of the peace, South Lorain, Ohio, concerning advantages of Lorain, Ohio, as site for proposed armor plant. (File Case A.)

AUGUST 13, 1897.

Letters were read and answered from the following:

Mr. James Maynard, Knoxville, Tenn., concerning the advantages of that place as site for proposed armor plant. (File Case A.)

Sailmaker Garrett Van Mater, U. S. N., concerning advantages of consulting Mr. Horance W. Lash as expert. (File Case B.)

AUGUST 14, 1897.

A letter was read and answered from M. A. Booker, Hampton, Va., concerning the advantages of that place as a site for the proposed armor plant. (File Case A.)

SOUTH BETHLEHEM, PA., *August 16, 1897.*

The board met at 10.30 a. m.

Present: All members.

Representatives of the Bethlehem Company informed the board that they would be prepared to receive it at the company's works at 2 p. m.

After some discussion in regard to the proposed visit to the works, a recess was taken until 1.30 p. m.

AFTER RECESS.

The board reconvened at 1.30.

Minutes of previous meetings were read and approved.

A letter was read from Mr. E. G. Wetherbee, calling attention to the advantages of Painesville, Ohio, as a site for an armor plant, and was ordered to be acknowledged and filed. (File Case A.)

After some discussion in regard to appointment of committees on buildings, machinery, etc., the board proceeded to inspect the works of the Bethlehem Company.

The following shops were visited:

Blacksmith shop No. 1. Witnessed: Forging of a 12-inch gun by hydraulic press.

Machine shop No. 2. Witnessed: Working of 10-inch disappearing gun; also working of pneumatic crane.

Armor-plate machine shop No. 3. Finished armor plates inspected.

Tempering plant Nos. 2 and 3. Witnessed: Tempering of an armor plate.

Adjourned at 5.30 to meet to-morrow, Tuesday, August 17, at 9.30 a. m., for further inspection of works.

Letters were received and answered from the following:

Mr. E. G. Wetherbee, Painesville, Ohio, concerning the advantages of Cleveland and Fairport Harbor as a site for the proposed armor plant. (File Case A.)

Mr. W. G. Howell, East Orange, N. J., making certain suggestions as to the process of manufacturing armor plates. (File Case E.)

AUGUST 17, 1897.

Board met at 9.30 a. m.

Present: All members.

Proceeded to further inspect the works of the Bethlehem Company, visiting the following shops:

Reheating furnace.

Hammer building. Witnessed: Forging of an armor ingot by hydraulic press.

Casting shop. Witnessed: Casting of an armor ingot.

Recess at 12.15 until 1.30.

AFTER RECESS.

Board reconvened at 1.30.

Proceeded to further inspect Bethlehem Works, visiting the following:

Hammer building. Witnessed: Reforging of a turret armor plate from 20 down to 15 inches, tapered to 17 inches, by hydraulic press. Also witnessed: Bending of a turret plate 15 inches thick.

Armor-erecting shed. Witnessed: Grinding of edges of belt armor for the U. S. S. *Kentucky.*

Adjourned at 5 p. m. until to-morrow, Wednesday, August 18, at 9.30, for further inspection of the works.

Letters were received and answered from the following:

Mr. J. M. Elliott, jr., mayor, Gadsden, Ala., concerning advantages of that place as a site for proposed armor plant. (File Case A.)

Mr. F. G. Dilret, Johnstown, Pa., concerning the advantages of that place as a site for proposed armor plant. (File Case A.)

Mr. John F. Oglevee, secretary Columbus, Ohio, Board of Trade, concerning advantages of Columbus as a site for proposed armor plant. (File Case A.)

Hon. T. S. Butler, M. C., forwarding a letter from Mr. Fred Baldt concerning advantages of the plant of the Wellman Iron and Steel Company, South Chester, Pa., for proposed armor plant. (File Case A.)

Mr. James S. Holmes, chairman Buffalo Real Estate Exchange, Buffalo, N. Y., concerning the advantages of Buffalo as a site for the proposed armor plant. (File Case A.)

Hon. D. S. Alexander, M. C., inclosing clipping from a Buffalo paper giving the views of Major Symons, United States Engineer Corps, concerning advantages of Buffalo as a site for proposed armor plant. (File Case A.)

Mr. W. F. Durfee, West New Brighton, Staten Island, offering his services as expert engineer. (File Case B.)

Mr. Frank A. Dennett, Boston, Mass., offering his services as mechanical expert. (File Case B.)

Hon. William W. Crapo, New Bedford, Mass., concerning the capabilities of Mr. William F. Durfee. (File Case B.)

Mr. William Kent, Covington, Ky., offering his assistance. (File Case B.)

AUGUST 18, 1897.

Board met at 9.30 a. m.

Present: All members.

Proceeded to further inspect the works of the Bethlehem Company, visiting the following shops:

Open-hearth furnaces, building No. 1. Witnessed: Forty-eight-inch ingot for 13-inch gun tube cast and pressed under hydraulic press. Also inspected rolling mill in same building, and witnessed shearing of protective-deck plate.

Oil-tempering plant No. 1. Witnessed: Oil tempering of small army gun forgings and connecting rod for Japanese cruiser.

Recess at 12.30 until 2.30 p. m.

AFTER RECESS.

Board reconvened at 2.30 p. m.

Agreed: To prepare schedules of requisites of an armor plant, by departments, to be distributed among the members for revision and enlargement.

Schedules of open-hearth plants and central power plants prepared.

The invitation of Col. Rollin H. Wilbur, general superintendent Lehigh Valley Railroad, to take a trip on the road on Friday next was declined, owing to press of business.

Adjourned at 4.30 until to-morrow, Thursday, August 19, at 9.30 a. m.

Letters were received and answered from the following:

Mr. J. F. Meigs, transmitting 38 photographs of various operations, taken in the Bethlehem Iron Works. (File Case A.)

Mr. P. V. Lawson, Menasha, Wis., concerning the advantages of that place as a site for the proposed armor plant. (File Case A.)

Mr. Alex. De Barril, Carroll, Md., concerning the advantages of Drum Point, Md., as a site for the proposed armor plant. (File Case A.)

AUGUST 19, 1897.

Board met at 9.30 a. m.

Present: All members.

Proceeded to further discuss requisites of an armor plant.

Agreed: To employ an expert, to serve three months or longer, to render such assistance as the board may require.

Captain McCormick and Chief Engineer Perry were appointed a committee to confer with Mr. John Fritz in regard to serving in that capacity and to ascertain what understanding could be reached which would be in accordance with the board's instructions and its interview with the Acting Secretary of the Navy.

After further discussion the board took a recess at 12.30 until 2.30 p. m.

AFTER RECESS.

Board reconvened at 2.30.

The committee appointed to confer with Mr. Fritz reported as follows: It found him favorably disposed to accept the board's proposal, but he would require time to consider it, and would communicate his decision later, the board in the meantime not being estopped from conferring with other specialists as to their employment. Mr. Fritz in his communication will state whether he can devote his whole time to the subject and what remuneration he would expect. He was informed that his services would probably not be required until after the return of the board to Washington, about a week or ten days hence.

The board then completed the preparation of its preliminary schedule of the requisites of an armor plant, and at 4.30 adjourned until to-morrow, August 20, 1897, at 2 p. m.

Letters were received and answered from the following:

Mr. C. M. Spaulding, Bridgeport, Conn., offering his services as draftsman. (File Case B.)

Mr. H. C. Harvey, president chamber of commerce, Huntington, W. Va., concerning a site for proposed armor plant. (File Case A.)

A letter was sent to Mr. C. M. Schwab, president of the Carnegie Steel Company, Pittsburg, Pa., informing him that the board will con ene in Pittsburg on Monday, August 24.

AUGUST 20, 1897.

Board assembled informally at 10 a. m. and proceeded to further inspect the plant of the Bethlehem Iron Company. Made a cursory inspection of the rail mill. Inspected the testing room and the laboratory, and then made a further inspection of the armor-plate machine shop.

Board met at 2 p. m.

Present: All members.

Reviewed schedules of requisites of an armor plant. Discussed the same. Adjourned at 3 p. m. until to-morrow, Saturday, August 21, at 9.30 a. m.

Letters were received and answered from the following:

Hon. O. W. Underwood, M. C., concerning character of steel produced at Birmingham, Ala. (File Case A.)

Mr. E. Mason Wick, Youngstown, Ohio, concerning the advantages of that place as a site for the proposed armor plant. (File Case A.)

Hon. H. R. Gibson, M. C., concerning the advantages of Knoxville, Tenn., as a site for the proposed armor plant. (File Case A.)

AUGUST 21, 1897.

Board met at 9.30 a. m.

Present: All members.

Proceeded to works of the Bethlehem Iron Company and reviewed the shops heretofore inspected, with especial reference to the open-hearth department, forging, cementing, and tempering plants.

Recess at 12.30 until 2.30.

AFTER RECESS.

Board reconvened at 2.30.

Agreed: That the following letter of thanks be addressed to the president of the Bethlehem Iron Company:

DEAR SIR: On behalf of the Armor Factory Board I have much pleasure in expressing our gratification at the thorough and complete manner in which we have been allowed to see the whole of the Bethlehem Iron Works and its processes. We were given admission to all departments, and all information asked for was courteously furnished by the representatives of the company.

For the above you will please accept our sincere thanks.

Very respectfully,

JOHN A. HOWELL,
Commodore and President.

ROBERT P. LINDERMAN, Esq.,
President Bethlehem Iron Company, South Bethlehem, Pa.

Adjourned at 3.15 to meet at Pittsburg, Pa., Tuesday, August 24, at 10 a. m.

PITTSBURG, PA., *August 24, 1897.*

Board met at 10 a. m.

Present: All members.

An invitation was received from Mr. Schwab, president of the Carnegie Steel Works, to visit the armor plant of the Carnegie Steel Works. Mr. Schwab also invited the board to visit the other works of the company in this vicinity, that the board might see the magnitude of the general works in comparison with that of the armor plant.

Invitation accepted; and it was decided to first inspect the armor plant and then give at least a day to the inspection of the rest of the works. It was also decided to show the orders under which the board is acting to a representative of the company.

Accordingly the orders to the board were read aloud in the presence of Mr. Schwab, the president, and Mr. Stone, both representing the Carnegie Steel Company.

Board proceeded to Munhall at 11 a. m., and inspected first the mold shop, with its drying ovens, and the open-hearth casting plant.

Recess at 12.30 until 1.30 for lunch.

AFTER RECESS.

The board visited the forge shop, the cementing and tempering shop, the armor-plate machine shop, the blacksmith shop, the electric power house, the pattern and templet shops, the microscopic laboratory, and finally the 32-inch blooming mill for rolling light armor plates.

The board returned to Pittsburg at 5 p. m.

Letters were received and answered from the following:

Mr. William S. Raynor, president Curtis Bay Company, Baltimore, Md., concerning the advantages of Curtis Bay as a site for the proposed armor plant. (File Case A.)

Mr. Albert C. Isaacs, general manager of the Coronet Steel Company, West Hoboken, N. J., concerning his improved process for making steel. (File Case E.)

Mr. Charles H. Pope, Moline, Ill., inquiring as to conditions for site for armor plant. (File Case A.)

AUGUST 25, 1897.

Board met at 9.30 a. m.

Present: All members.

Agreed, To visit the Illinois Steel Works, Chicago, Ill., on Monday, August 30, the board to convene at Chicago on Monday morning for that purpose.

Letter and telegram sent to and telegraphic reply received from the president of the Illinois Steel Company, stating he would be pleased to show the board his works on that day.

Proceeded to visit the works of the Carnegie Steel Company at Munhall at 10 a. m. Revisited the forging shop and cementing and tempering plants.

Recess at 12.30 until 1.30.

AFTER RECESS.

Passed through the various shops of the works outside of the armor plant, and then examined the armor-plate machine shop in detail.

Adjourned at 4 p. m.

Letters were received and answered from the following:

Hon. L. Danford, M. C., inquiring if the work of the Armor Factory Board includes looking after sites for manufacturing purposes. (File Case A.)

Capt. P. F. Harrington, U. S. N., forwarding letter of Sailmaker Garrett Van Mater, recommending Mr. Lash as expert. (File Case B.)

AUGUST 26, 1897.

Board met at 9.30 a. m.

Present: All members.

Proceeded to visit the general works of the Carnegie Steel Company.

Visited the Duquesne Works; examined the great blast furnaces and witnessed operations of smelting ores and producing pig iron, both ordinary and basic.

Visited the Edgar Thompson Works at Braddock, and witnessed the operations of the great rail mills.

A short visit was also made to the electric department of the Westinghouse Company at East Pittsburg.

Board returned to Pittsburg at 4 p. m.

Letters were received and answered from the following:

Hon. J. H. Davidson, M. C., concerning the advantages of Menasha, Wis., as a site for the proposed armor plant. (File Case A.)

Mr. A. W. Willis, president Sheffield Coal, Iron, and Steel Company, Nashville, Tenn., concerning the advantages of Sheffield, Colbert County, Ala., as a site for the proposed armor plant. (File Case A.)

Mr. Samuel J. Taylor, Indianapolis, Ind., concerning the advantages of Michigan City, Ind., as a site for proposed armor plant. (File Case A.)

Hon. James Hamilton Lewis, M. C., concerning the advantages of Seattle and Tacoma as sites for the proposed armor plant. (File Case A.)

Mr. John P. Sears, secretary Anderson Commercial Club, Anderson, Ind., concerning the advantages of Anderson as a site for the proposed armor plant. (File Case A.)

Mr. F. W. Wood, president Maryland Steel Company, Sparrows Point, Md., concerning the consideration of that point as a site for the proposed armor plant. (File Case A.)

Hon. T. H. Bankhead, M. C., concerning the advantages of Birmingham, Ala., as a site for the proposed armor plant. (File Case A.)

Hon. O. W. Underwood, M. C., concerning the advantages of Birmingham, Ala., as a site for the proposed armor plant. (File Case A.)

AUGUST 27, 1897.

Board met at 9.30 a. m.

Present: All members.

Agreed, To defer interviewing certain people in Pittsburg who had been recommended as experts in furnishing estimates of the cost of an armor plant until the board had arrived at a thorough conception of the needs thereof.

At 10 a. m. board proceeded to Munhall and further examined—
The beam-rolling mill.
The 32-inch bloom or deck-plate mill.
The open-hearth department.
Returned to Pittsburg at 12.30 p. m.
Recess, 12.30 until 1.30.

AFTER RECESS.

The board agreed to send the following letter to Mr. C. M. Schwab, president of the Carnegie Steel Company:

DEAR SIR: On behalf of the board ordered to consider the question of establishing a Government armor plant, I have much pleasure in expressing our gratification at the courteous manner in which you have received us and the thorough way in which you have shown us the works of the Carnegie Steel Company and its processes. You freely admitted us to all departments and all information asked for was cheerfully furnished by the representatives of the company.

For the above please accept our sincere thanks.

Respectfully,

JOHN A. HOWELL,
Commodore, U. S. N., President Armor Factory Board.

Mr. C. M. SCHWAB,
President Carnegie Steel Company, Pittsburg, Pa.

The board then adjourned to meet in Chicago Monday, August 30.

Letters were received and answered from:

Hon. W. E. Chandler, U. S. S., concerning the advantages of Sheffield, Ala., as a site for the proposed armor plant and the desideratum in the premises. (File Case A.)

Hon. H. B. Tuthill, Michigan City, Ind., concerning the advantages of that place as a site for the proposed armor plant. (File Case A.)

Mr. M. V. Richards, land and industrial agent, Southern Railway, Washington, D. C., concerning a trip to sites offered for the location of the proposed armor plant along the line of the Southern Railway. (File Case D.)

CHICAGO, ILL., *August 30, 1897.*

Board met at 10 a. m.

Present: All members.

Telegram from Mr. John Fritz, inquiring when and where he could confer with board, read and answered.

Agreed, That next meeting of the board in Washington should be at 10 a. m., Tuesday, September 7.

Letter from mayor of Waukegan, Ill., inviting board to visit that city with reference to a site for armor plant, read and answered. (File Case A.)

Letter from Hon. Ernst G. Timme, Auditor for the State and other Departments, calling attention to advantages of Kenosha, Wis., as a site for armor plant, read and answered. (File Case A.)

Agreed, That the board take no action in regard to sites until it receives more specific instructions from the Secretary of the Navy.

At 10.27 a. m. the board proceeded to South Chicago, Ill., and inspected the works of the Illinois Steel Company.

Inspected in detail the open-hearth department and witnessed the running of a heat from one of the rotary open-hearth furnaces.

After lunch, from 1.30 to 2.30 p. m.—

Inspected the two great blast-furnace plants, the plate-rolling mill, the great rail mill, the Bessemer plant, the stock yards, the rapid unloading of ore from steamers at the docks, the water front, and the space available for further extension of plant. After a brief inspection of the chemical and microscopic laboratories, the board returned to Chicago at 5.48 p. m.

AUGUST 31, 1897.

Board met at 9.30 a. m.

Present: All members.

Minutes of previous meetings read and approved.

Agreed: That the following letter of thanks be sent to the president of the Illinois Steel Company:

DEAR SIR: On behalf of the board ordered to consider the question of establishing a Government armor plant, I have much pleasure in expressing our gratification at the courteous manner in which we were received and the thorough way in

which we were shown the works of the Illinois Steel Company and its processes. We were freely admitted to all departments and all information asked for was cheerfully furnished by the representatives of the company.

For the above please accept our sincere thanks.

Very respectfully,

JOHN A. HOWELL,
Commodore, U. S. N., President Armor Factory Board.

Mr. J. W. GATES.
President Illinois Steel Company, Chicago, Ill.

Adjourned at 10 a. m. to meet in Washington, Tuesday, September 7, 1897.

WASHINGTON, D. C., *September 7, 1897.*

Board met at 10 a. m.

Present: All the members except Commodore Howell.

A letter was read from Commodore Howell, stating that owing to a death in his family he would not be present until Wednesday, September 8.

Letters were read and answered from the following:

Mr. Douglas Benson, secretary Board of Trade, Erie, Pa., concerning Erie as a site for the proposed armor plant. (File Case A.)

Hon. Joseph Wheeler, M. C., concerning the advantages of Sheffield, Ala., as a site for proposed armor plant. (File Case A.)

Mr. Edward C. Meier, The Heine Safety Boiler Company, Philadelphia, Pa., sending his book, Helios, on the subject of his safety boiler. (File Case G.)

Hon. Eugene P. Stofer, secretary Board of Trade, Reading, Pa., concerning the advantages of Reading, Pa., as a site for the proposed armor plant. (File Case A.)

Mr. William D. Kelly, secretary of the Chamber of Commerce, Muskegon, Mich., concerning the advantages of Muskegon as a site for the proposed armor factory. (File Case A.)

Mr. S. Spencer, president Southern Railway Company, New York, concerning the advantages of Birmingham, Ala., as a site for the proposed armor plant. (File Case A.)

Mr. M. B. Harlow, president Business Men's League, Alexandria, Va., concerning the advantages of Alexandria as a site for the proposed armor plant. (File Case A.)

Mr. J. E. Sherman, mayor, Marquette, Mich., requesting a copy of the board's orders. (File Case A.)

Adjourned at 10.45 until to-morrow, Wednesday, September 8, to allow furnishing of room assigned for occupancy of the board.

SEPTEMBER 8, 1897.

Board met at 10 a. m.

Present: All members.

Minutes of previous meetings read and approved.

Telegram received from Mr. John Fritz, stating that he was unwell, but hoped to be all right in a few days.

Proceeded to discuss requisites of an armor plant.

Mr. John Cassells, representing the Maryland Steel Company, appeared and invited the board to visit the works of that company. The board directed that he be shown a copy of its orders.

A representative of the Associated Press was admitted, and the board directed that he also be shown a copy of its orders.

Recess at 12.30 until 2.

AFTER RECESS.

Reconvened at 2 p. m.

Further discussed requisites of an armor plant.

Adjourned at 4 p. m. until to-morrow, Thursday, September 9, at 10 a. m.

Letters were received and answered from the following:

Mr. Jacob Reese, Philadelphia, Pa., offering his services as counsel. (File Case B.)

Mr. C. P. Tatro, Seattle, Wash., concerning certain mines of chromic iron on one of the islands of Puget Sound. (File Case A.)

SEPTEMBER 9, 1897.

Board met at 10 a. m.

Present: All members.

Proceeded to consider requisites of an armor plant.

Recess at 12.30 until 2.30.

AFTER RECESS.

Reconvened at 2.30.
Further considered requisites of an armor plant.
Adjourned at 4 p. m. until to-morrow, Friday, September 10, at 10 a. m.
Letters were received and answered from the following:
Hon. S. B. Cooper, M. C., concerning the advantages of New Birmingham, Tex., as a site for the proposed armor plant. (File Case A.)
Mr. Frederick S. Duncan, New York City, concerning the presence of Mr. John H. R. Whinfield upon a special mission from Sir W. G. Armstrong, Whitworth & Co., Limited. (File Case C.)
Mr. John Fritz, Bethlehem, Pa., stating that owing to illness he could not meet the board at present. (File Case C.)
Mr. William Kent, Covington, Ky., concerning cost of making armor and making certain suggestions to guide in establishing a plant. (File Case C.)
Hon. George W. Steele, Marion, Ind., concerning the advantages of Marion, Ind., as a site for the proposed armor plant. (File Case A.)

SEPTEMBER 10, 1897.

Board met at 10 a. m.
Present: All members.
Proceeded to consider details of an armor plant.
Hon. Joseph Wheeler, M. C., appeared and invited the board to visit Alabama with reference to a site for armor plant. He was shown a copy of the orders under which the board is acting.
Recess at 12.30 to 1.30.

AFTER RECESS.

Board reconvened at 1.30.
Further discussed the details of an armor plant.
Telegram received from Mr. John Fritz, stating that his physician thinks he will be able to be in Washington Monday next.
Adjourned at 4 p. m. until to-morrow, Saturday, September 11, at 10 a. m.
Letters were received and answered from the following:
Mr. J. B. Duble, president Board of Trade, Williamsport, Pa., concerning the advantages of Williamsport, Pa., as a site for the proposed armor plant. (File Case A.)
Hon. Page Morris, Duluth, Minn., concerning the advantages of Duluth as a site for the proposed armor plant. (File Case A.)
Mr. William P. Palmer, second vice-president, Illinois Steel Company, Chicago, Ill., concerning drawings and data which he intends to send. (File Case C.)

SEPTEMBER 11, 1897.

Board met at 10 a. m.
Present: All the members.
A letter was received and answered from Mr. Frederick S. Duncan, New York City, appointing Friday, September 24, at 10.30 a. m., as the time for Mr. Whinfield to meet the Armor Factory Board. (File Case C.)
Letters requesting catalogues of tools, heavy machinery, etc., were sent to the following (see letter book):
William Sellers, Philadelphia, Pa.
Morgan Engineering Co., Alliance, Ohio.
Bement, Miles & Co., Philadelphia, Pa.
Pond Machine Company, New York.
Niles Tool Works, Hamilton, Ohio.
Proceeded to discuss details of an armor plant.
Adjourned at 12 m. until Monday, September 13, at 10 a. m.

SEPTEMBER 13, 1897.

Board met at 10 a. m.
Present: All members.
Minutes of last two meetings read and approved.
Proceeded to consideration of details of an armor plant.
Recess at 12 o'clock until 1.30.

AFTER RECESS.

Reconvened at 1.30.
Further considered details of an armor plant.
Adjourned at 3.45 until to-morrow, Tuesday, September 14, at 10 a. m.
Letters were received and answered from the following:

Hon. O. W. Underwood, M. C., concerning a visit to Birmingham and the advantages of that city as a site for proposed armor plant. (File Case A.)

Mr. A. J. Boyce, East Liverpool, Ohio, concerning the advantages of a certain plat of land in Hancock County, W. Va., as a site for proposed armor plant. (File Case A.)

SEPTEMBER 14, 1897.

Board met at 10 a. m.

Present: All the members.

Representatives Wheeler, Gaines, and Livingston and Commissioner of Pensions Evans appeared and urged the board to visit the Tennessee-Alabama iron and steel district with reference to a suitable site for an armor plant. They were shown a copy of the board's orders, and it was explained to them that the details of an armor plant would occupy the exclusive attention of the board for some time.

Mr. W. E. Deaton, chairman Board of Trade, Roanoke, Va., appeared and presented a letter concerning the advantages of Roanoke as a site for the proposed armor plant and invited the board to visit that place. He was advised of the existing orders of the board and that his communication would be filed for future reference.

Mr. John Fritz, of Bethlehem, Pa., then appeared and informed the board that he was prepared to serve as its expert for the sum of about $15,000, the service to extend over a period of about five months, and all drawings and estimates to be furnished at his own expense under the direction of the board.

Letters were addressed to the Honorable Secretary of the Navy on the following subjects:

Requesting that the board be not ordered to visit the Alabama-Tennessee iron district until the plans of the armor plant with which it is now engaged are sufficiently advanced to make the continued presence of the board at its offices no longer necessary.

Requesting authority to employ Mr. John Fritz as expert to the board.

Upon invitation of the Acting Secretary of the Navy the board called upon him in a body, taking Mr. Fritz.

The Assistant Secretary thought the remuneration a fair one, but that he would have to confer with the Secretary of the Navy before he could say whether an arrangement with Mr. Fritz could be entered into.

The board then returned to its meeting room, and Commodore Howell stated that during his conversation with the Acting Secretary he brought up the subject of visiting sites and said he would recommend to the Secretary that the orders of the board be altered so as to authorize and direct the board to visit sites only at a time convenient to it.

After a further talk with Mr. Fritz the board adjourned at 1.05 until to-morrow, Wednesday, September 15, 1897, at 10 a. m.

SEPTEMBER 15, 1897.

Board met at 10 a. m.

Present: All members.

Minutes of previous meetings read and approved.

Letter read and answered from Hon. S. B. Elkins, U. S. S., inclosing one from mayor of Piedmont, W. Va., and others, inviting attention to desirability of Morrison Island as a suitable site for an armor plant; also letters from the following, suggesting that the board visit the Tennessee-Alabama district: Hon. T. C. Platt, U. S. S., and Hon. William Stewart, U. S. S.; also letters from Governor G. W. Atkinson, of West Virginia, and Governor A. Y. Atkinson, of Georgia, suggesting that the board visit the South with reference to locating an armor plant in that section. (File Case A.)

Proceeded to further consider details of an armor plant.

Recess at 12.30 until 2 p. m.

AFTER RECESS.

Board reconvened at 2 p. m.

Further considered details of an armor plant.

Adjourned at 3.50 until to-morrow, Thursday, September 16, at 10 a. m.

SEPTEMBER 16, 1897.

Board met at 10 a. m.

Present: All members.

Minutes of previous meetings read and approved.

Hon. O. W. Underwood, M. C., and Hon. Henry D. Clayton, M. C., appeared and urged the board to visit the Alabama section with a view to selection of a site.

stating, however, that it would not be well to visit there before the last of October or the 1st of November, on account of the warm weather and the yellow fever. The board's orders on the subject were explained to them.

Letters from Hon. Robert L. Taylor, governor of Tennessee, and E. W. Cole, suggesting that the board visit the South with reference to a suitable site for the proposed armor plant, were read and answered. (File Case A.)

Proceeded to consider details of an armor plant.

Recess at 12.30 until 2 p. m.

AFTER RECESS.

Reconvened at 2 p. m.

Further considered details of an armor plant.

Agreed: That Captain McCormick and Chief Engineer Perry visit Philadelphia Monday, September 20, and South Bethlehem, Pa., for the purpose of getting information in regard to machine tools.

Adjourned at 3 p. m. until to-morrow, Friday, September 17, at 10 a. m.

SEPTEMBER 17, 1897.

Board met at 10 a. m.

Present: All members.

Ensign C. B. McVay, jr., appeared and laid before the board his statements of estimates on machines and other details of an armor plant. Some of the data furnished by Mr. McVay were at his request agreed to be regarded as confidential. The board questioned Mr. McVay concerning the data furnished and the observations made by him while inspector of ordnance at the works of the Carnegie Steel Company. (File Case C.)

A letter was read and answered from Hon. Joseph J. Johnston, governor of Alabama, concerning that State as a suitable location for an armor plant. (File Case A.)

Adjourned at 2 p. m., to meet on Friday, September 24, at 10 a. m., unless a meeting should be sooner called.

SEPTEMBER 20, 1897.

Board met at 10 a. m., pursuant to call by the president.

Present: All members.

Proceeded to call upon the Acting Secretary of the Navy, Mr. Roosevelt, at his request.

The Acting Secretary stated that he had received a reply to the board's letter, from Secretary Long, concerning the employment of an expert, and in substance informed the board that its report must be submitted not later than December 1, and that it must be in as complete a state as possible; that the board should visit Birmingham, in the South, and that although the Secretary did not entirely approve of the employment of Mr. Fritz, he agreed, upon the recommendation of the board, to urge that Mr. Fritz be employed.

The board then returned to its place of meeting, and the question arose where the detail work on the plans should be done, and it was decided to draw up the following memorandum and submit it to the Acting Secretary for approval:

MEMORANDUM.

The board agrees that in the event of their succeeding in employing an expert, such expert shall come to the board's place of meeting in Washington to confer with the board as to the details of the various shops, and the board, after such conference, having determined the details, the expert be permitted to work where he pleases in putting these details into plans; and if at any time he should require further instructions, that a committee of the board be authorized to confer with him at his place of business.

It would be in contemplation that whenever the full board desired the presence of the expert, he would come to their place of meeting in Washington and bring with him plans, etc., as far as completed.

This proposition of the board is entirely in accord with the precedents in the department. For instance, the Bureau of Navigation has had plans and specifications for improvements at Newport and other points made by architects in Philadelphia and elsewhere, and the Bureau of Yards and Docks has had plans furnished it by people outside of the Department.

It would not only be more economical to pursue the plan above outlined, but would tend to the dispatch of business, in the opinion of the board.

This memorandum was submitted to the Acting Secretary by the president, who returned and stated that it was perfectly satisfactory to the Acting Secretary.

The board then further considered the instructions to members about to visit Bethlehem, looking to the negotiations with Mr. John Fritz for his employment, if it should be approved by the Secretary of the Navy.

Recess at 12.30 until 1.30.

AFTER RECESS.

Reconvened at 1.30.

Agreed to take advantage of the absence of two of the members at Bethlehem to inspect the plant of the Maryland Steel Company, at Sparrows Point, Md.

Col. John Cassells, representing the company, appeared by request, and it was decided to visit the works of the company to-morrow, Tuesday, September 21, meeting at the railway station at 10 a. m. for that purpose.

Letters were read and answered from the following:

Mr. John F. Thomas, Webster, Pa., concerning Carroll Township, Washington County, Pa., as a suitable location for an armor plant.

Mr. L. S. Freeman, chairman reorganization committee, East Tennessee Land Company, concerning advantages of Harriman, Tenn., as a site for proposed armor plant. (File Case A.)

Mr. W. A. Chapman, concerning the right of Mr. William E. Corey to the protection of Patent No. 541594, covering certain processes in the manufacture of armor plate.

Mr. G. B. Mortimore, East Toledo, Ohio, relative to new process owned by Mr. J. T. Henry, of Allegheny City, for making armor. (File Case E.)

Mr. William P. Palmer, second vice-president of the Illinois Steel Company, forwarding photographs, plans, etc., of the Illinois Steel Company, and concerning negotiations for purchase of property for site for armor plant. (File Case C.)

Adjourned at 4 p. m.

SEPTEMBER 21, 1897.

Board met at 10 a. m.

Present: All members except Captain McCormick and Chief Engineer Perry.

Proceeded to Sparrows Point, Md., to inspect the works of the Maryland Steel Company, arriving at 11.45.

Recess at 1.30 until 2.30 for lunch.

AFTER RECESS.

Further inspected the works.

Returned to Washington at 6.30 p. m.

SEPTEMBER 22, 1897.

Board met at 10 a. m.

Present: All members except Captain McCormick and Chief Engineer Perry.

The following letters were read and answered, concerning sites (File Case A):

Thos. McCann, Lorain, Ohio.

W. T. Atkins, Jefferson, Tex., and vicinity.

J. S. Jamesson, Piedmont, W. Va.

J. J. Newman, points on Southern Railway.

A letter from the Acting Secretary of the Navy was read, concerning the numerous requests from different parts of the country, directing the board to sift out the few places worth serious consideration and then to have one or more members of the board visit them. (File Case F.)

Recess at 12.30 until 2 p. m.

AFTER RECESS.

Reconvened at 2 p. m.

Further discussed the question of sites and methods of elimination directed by the Acting Secretary of the Navy.

Representative Joseph Wheeler appeared and requested the board to include Sheffield, Ala., in its visit to the South.

Adjourned at 4 p. m. until to-morrow, Thursday, September 23, at 10 a. m.

SEPTEMBER 23, 1897.

Board met at 10 a. m.

Present: All members.

Minutes of previous meetings read and approved.

Captain McCormick and Chief Engineer Perry reported that they had visited Bethlehem, Pa., and conferred with Mr. Fritz, and found him willing to serve the board as expert under the conditions suggested by the Acting Secretary.

A form of agreement between Mr. Fritz and the board was drawn up and approved by the board, and sent to Mr. Fritz for his signature.

Captain McCormick and Chief Engineer Perry reported that they had secured the information they were directed to obtain from the Bethlehem Iron Company, and that they had visited the works of Sellers and Bement, Miles & Co., Philadelphia, and secured information in regard to heavy machine tools, which they laid before the board.

Mr. Frederick S. Duncan and Mr. John H. R. Whinfield, representing Armstrong, Whitworth & Co., appeared and made inquiries in regard to submitting proposals for furnishing heavy machine tools for armor-plate work.

The following letters were received and answered:

From James B. Ladd, relative to employment of Mr. Henry Aiken as expert. (File Case B.)

Messrs. Hulse & Co., Manchester, England, inviting the board to visit their Ordsal Works to receive particulars of machine tools specially designed for dealing with armor plates. (File Case D.)

Recess at 1.30 until 2.30.

AFTER RECESS.

Reconvened at 2.30.

Proceeded to discuss details of an armor plant.

Adjourned at 3.30 p. m. until to-morrow, Friday, September 24, at 10 a.m.

SEPTEMBER 24, 1897.

Board met at 10 a. m.

Present: All members.

A letter from Hon. Thomas C. Butler, M. C., concerning advantages of the Wellman Iron and Steel Company, of Chester, as a site for proposed armor plant, was read and answered. (File Case A.)

Agreed: Not to accept free transportation during any visits that the board may make.

Proceeded to discuss details of an armor plant and to revise the data already prepared in regard thereto.

Recess at 12.30 until 2 p. m.

AFTER RECESS.

Reconvened at 2 p. m.

Further discussed details of an armor plant and completed revision of data already prepared in regard thereto.

Adjourned at 4 p. m. until to-morrow, Saturday, September 25, at 10 a. m.

SEPTEMBER 25, 1897.

Board met at 10 a. m.

Present: All members.

Minutes read and approved.

Discussed details of an armor plant.

Recess at 12 until 1 p. m.

AFTER RECESS.

Reconvened at 1 p. m.

Telegram received from Mr. John Fritz announcing that he had signed the agreement mailed to him on the 23d.

The president, after a conference with the Acting Secretary of the Navy, announced that the latter had authorized the employment of Mr. Fritz.

Telegram sent to Mr. Fritz to meet the board at Navy Department on Monday, September 27.

Adjourned at 3 p. m. to meet on Monday, September 27, at 10 a. m.

SEPTEMBER 27, 1897.

Board met at 10 a. m.

Present: All members except Commodore Howell, who later appeared.

Minutes read and approved.

Letters read and answered from:

Mr. A. S. Buford, chairman Richmond, Va., Chamber of Commerce, in reference to conference with the board. (File Case A.)

Mr. S. M. Felton, in reference to the merits of Harriman, Tenn., as a site for the proposed armor plant. (File Case A.)

Letters from the Chief of Bureau of Ordnance and from the Chief of Bureau of

Construction and Repair, in answer to letters addressed them on the 16th instant, were read, in which these officials stated the dimensions of the largest armor plate that would probably be required in future. (File Case C.)

The Chief of Bureau of Ordnance appeared, by request of the board, and was questioned in regard to the dimensions of armor plates. He later furnished the board with an additional statement concerning the dimensions of furnaces and tools which, in his judgment, the board should provide for such plates. (File Case C.)

Proceeded to consider the revision of details and dimensions of tools for an armor plant.

Recess at 1 p. m. until 1.30.

AFTER RECESS.

Reconvened at 1.30 p. m.

Mr. John Fritz appeared at 1.45 p. m., with whom the board proceeded to discuss and revise the details already considered. A memorandum of these details was then handed to Mr. Fritz, who was accordingly directed to proceed with work upon the plans.

The president of the board, accompanied by Mr. Fritz and the Judge-Advocate-General, called upon the Acting Secretary of the Navy, and the letter of agreement to act as expert, signed by Mr. Fritz, was submitted. The president returned and stated that the Acting Secretary had approved the agreement and had given orders for the drawing up of a formal contract by the Judge-Advocate-General.

Adjourned at 4 p. m. until Tuesday, September 28, at 10 a. m.

SEPTEMBER 28, 1897.

Board met at 10 a. m.

Present: All members.

Minutes read and approved.

Proceeded to discuss the apportionment of work among the members. The following memorandum was approved by the board:

MEMORANDUM.

That the board divide into three committees:

1. Commodore Howell, with the assistance of Lieutenant Chambers, the recorder, and the stenographer, Mr. De Knight, to draft report.

2. Captain McCormick and Chief Engineer Perry to have charge of all machine tools, furnaces, and other shop appliances, and rolling stock.

3. Civil Engineer Endicott and Lieutenant Fletcher to have charge of all buildings, foundations, railroad beds, sewers, and water supply.

The committees, upon call from the expert, to fully and freely consult with him at his place of business and make decision on points requiring settlement.

While awaiting such calls, the board to stand adjourned subject to recall by its president for the transaction of any business requiring the full board's presence.

That the recorder, under directions from the president, dispose of all routine business.

That the board do not travel for the inspection of locations prior to the middle of October, in order that the committees may be available for consultation with the expert.

This memorandum was subsequently submitted by the president of the board to the Acting Secretary of the Navy, and by him approved.

Discussed the duty of the board in regard to visiting sites or locations.

Recess at 12.45 until 2 p. m.

AFTER RECESS.

Reconvened at 2 p. m.

Further discussed the question of visiting certain sites.

Adjourned at 3 p. m. until to-morrow, Wednesday, October 29, at 10 a. m.

SEPTEMBER 29, 1897.

Board met at 10 a. m.

Present: All the members.

Minutes read and approved.

Discussed methods of proceeding with work.

At 11 a. m. the board visited the honorable Secretary of the Navy, by appointment, at which meeting he was informed of the progress made and the methods outlined for future work by the board, all of which was by him approved.

The memorandum concerning the future work of the board, recorded in the minutes of the last meeting, was shown to the Secretary of the Navy and met with his approval.

The board also conferred with the Secretary of the Navy in regard to visiting localities as outlined in the following memorandum, and he authorized visits to the places recommended in this memorandum:

MEMORANDUM.

The board is of the opinion that it might be advisable, if time permitted, for the whole board to visit Knoxville, Tenn.; Chattanooga, Tenn.; Birmingham, Ala.; Sheffield, Ala.; Marion, Ind.; Columbus, Ohio; Piedmont, W. Va. This trip would consume about two weeks. The board does not think it could spare this much time, and it recommends that the visit be limited to Knoxville, Chattanooga, Birmingham, Sheffield, and return to Washington, taking in Knoxville and Chattanooga on the way back.

The board returned to its place of meeting at 11.40 a. m.

A letter was read and answered from Messrs. J. C. Byars and C. L. Bunting, representing the Board of Trade, Bristol, Tenn., concerning the suitability of that place as a site for an armor plant. (File Case A.)

Further discussed the methods of procedure with work.

Minutes of this day's proceedings read and approved.

Adjourned at 12.45 p. m., subject to call.

SEPTEMBER 30, 1897.

Letters were received and answered from the following:

Mr. H. C. Harvey, president Chamber of Commerce, Huntington, W. Va., concerning the advantages of Huntington as a site for the proposed armor plant. (File Case A.)

Mr. M. V. Richards. land and industrial agent, Southern Railway, concerning arrangements for transporting the board through the South. (File Case D.)

Mr. Ed. H. Zurhorst, Sandusky, Ohio, requesting the names of the board. (File Case A.)

Telegram from Hon. O. W. Underwood, requesting to be informed of date of departure of board South. (File Case D.)

OCTOBER 1, 1897.

Letters were written to the following on the subject of sites:
Hon. J. H. Davidson, M. C.
Hon. D. S. Alexander, M. C.
Hon. Ernest G. Timme, Auditor for the State and other Departments.
Hon. Loren M. Fletcher, M. C.
Mr. Charles H. Pope, Moline, Ill.
Hon. James H. Lewis, M. C.
Mr. W. T. Atkins, Jefferson, Tex.
(See File Case A.)

OCTOBER 2, 1897.

A letter was received and answered from Mr. R. A. Dunlop, secretary of committee, Richmond Chamber of Commerce, requesting a hearing before the board concerning the advantages of Richmond, Va., as a site for the proposed armor plant. (File Case A.)

OCTOBER 4, 1897.

Letters were received and answered from the following:

Mr. H. S. Chamberlain, chairman of special committee, Chamber of Commerce, Chattanooga, Tenn., inviting the board to visit that city during its trip South. File Case A.)

Hon. O. W. Underwood, M. C., concerning his anxiety to know the date of the board's anticipated arrival at Birmingham, Ala. (File Case D.)

Mr. William F. Mason McCarty, engineer, New York City, concerning his method of casting armor plates. (File Case E.)

Hon. John H. Stephens, M. C., concerning the advantages of Jefferson, New Birmingham, or Rusk, Tex., as sites for the proposed armor plant. (File Case A.)

Hon. Joseph Wheeler, M. C., concerning the date of departure of the board for the South. (File Case D.)

Mr. R. D. Gilliam, secretary Chamber of Commerce, Petersburg, Va., concerning the advantages of that city as a site for the proposed armor plant. (File Case A.)

OCTOBER 5, 1897.

Letters were received and answered from the following:

Hon. R. Q. Mills, U. S. S., concerning the advantages of Jefferson, Tex., as a site for the proposed armor plant. (File Case A.)

Mr. William G. Sheen, Bristol, Tenn., concerning the advantages of that place as a site for the proposed armor plant. (File Case A.)

OCTOBER 6, 1897.

Received and answered letter from Hon. James L. Slayder, M. C., concerning merits of Jefferson, Tex., as a suitable site for an armor plant. (File Case A.)

Received and filed a report on the advantages of Elizabethton and the Watauga Valley as a site for an armor plant. (File Case A.)

The board was directed by the honorable Secretary of the Navy to include in its contemplated visit to the South the town of Elizabethton, Tenn.

Letter from S. W. Williams, secretary Board of Trade, on Harriman, Tenn., as a site for proposed armor plant. (File Case A.)

OCTOBER 7, 1897.

Letters received and answered from:

Hon. A. Hinchman, ex-mayor, concerning advantages of Waco, Tex., as a site for proposed armor plant. (File Case A.)

Mr. W. R. Broaddus, real estate agent, concerning advantages of West Point, Va., as a site for proposed armor plant. (File Case A.)

Hon. Rudolph Kleberg, M. C., concerning advantages of Jefferson, Tex., as a site for the proposed armor plant. (File Case A.)

OCTOBER 8, 1897.

Letter received and answered from Hon. T. S. Plowman, Talladega, Ala., concerning advantages of Birmingham, Ala., and requesting that full board visit that city. (File Case A.)

Letters stating that the board expects to leave for Birmingham October 16 were sent to Hon. O. W. Underwood, Hon. Jos. Wheeler, Mr. M. V. Richards, industrial agent Southern Railway.

OCTOBER 9, 1897.

Letters were received and answered from the following:

Hon. Loren Fletcher, M. C., inquiring if Duluth, Minn., and Superior, Wis., had been heard from in regard to sites. (File Case A.)

Mr. W. T. Atkins, Jefferson, Tex., concerning the advantages of that place as a site for proposed armor plant. (File Case A.)

Letters were sent to the following (letter book):

Mr. C. M. Spalding, Bridgeport, Conn., concerning his tender of services as draftsman.

Mr. W. G. Howell, East Orange, N. J., concerning his tender of expert assistance.

Mr. C. Colne, New York, concerning the submission of a new process for armor-plate manufacture.

Mr. Frank A. Dennette, Boston, Mass., concerning his tender of services as mechanical expert.

Mr. J. E. Blackburn, Columbus, Ohio, concerning an improved process for the manufacture of steel.

Mr. Albert C. Isaacs, West Hoboken, N. J., concerning his improved process for making steel.

Mr. James H. Carpenter, Reading, Pa., concerning his improved methods in the manufacture of steel and armor plate.

Mr. William Durfee, Staten Island, N. Y., concerning his services as an expert engineer.

Mr. William Kent, Covington, Ky., concerning his offer of assistance.

OCTOBER 12, 1897.

Letters were received and answered from the following:

Hon. W. G. Brantley, M. C., concerning the advantages of Blythe Island, Georgia, as a site for the proposed armor plant. (File Case A.)

Hon. Jos. F. Johnston, governor of Alabama, expressing the hope that the board will be in the State of Alabama by the 18th instant. (File Case A.)

Hon. J. M. Elliot, jr., mayor of Gadsden, Ala., conveying an invitation to visit that place. (File Case A.)

Mr. J. C. Byars, secretary and treasurer Bristol (Tenn.) Board of Trade, urging the board to visit that city. (File Case A.)

A committee composed of W. C. Bullitt, D. W. Flickwir, and Jos. S. Miller called and requested the board to include a visit to Roanoke, Va., during its trip to the South.

OCTOBER 13, 1897.

Letter sent to the Chief of Bureau of Construction and Repair, requesting information as to greatest length and diameter of armor bolts for both turret and side armor, etc.

OCTOBER 14, 1897.

Letters were received and answered from the following:
Hon. A. Hinchman, ex-mayor, Waco, Tex., concerning the value of his ore beds near Waco. (File Case A.)

Hon. John W. Cranford, M. C., concerning the advantages of Jefferson, Tex., as a site for the proposed armor plant. (File Case A.)

Hon. H. Chilton, Tyler, Tex., concerning the advantages of Jefferson and New Birmingham, Tex., as sites for the proposed armor plant. (File Case A.)

Mr. Gilbert H. Stewart, president Board of Trade, Columbus, Ohio, making certain inquiries as to the plans of the board in regard to sites. (File Case A.)

Mr. William James, St. James, Mo., concerning the advantages of a place near St. James as a site for the proposed armor plant. (File Case A.)

Civil Engineer M. T. Endicott and Lieut. F. F. Fletcher ordered to proceed to Bethlehem, Pa., for duty as directed, on Friday, October 15, and upon completion of this duty to return to Washington and resume their regular duties with the board.

OCTOBER 15, 1897.

Letters were received and answered from the following:
Mr. M. V. Richards, land and industrial agent, Southern Railway, relative to the board meeting Mr. Elliott, mayor of Gadsden, Ala., at Birmingham, Monday morning. (File Case D.)

Mr. George W. Miles, Radford, Va., concerning the advantages of Radford as a site for the proposed armor plant. (File Case A.)

Hon. W. Brewer, M. C., extending a cordial invitation to the board to visit Birmingham. (File Case A.)

Mr. E. E. Downham, chairman of committee, Board of Trade, Alexandria, Va., inviting the board to visit Alexandria before its return South. (File Case A.)

A telegram was received and answered from:

J. G. Osborn, esq., president Board of Trade, Radford, Va., inviting the board to visit Radford on its way South, and requesting an itinerary of the trip. (File Case A.)

OCTOBER 16, 1897.

Board met at 1 p. m., pursuant to call.
Present: All members.

Captain McCormick and Chief Engineer Perry, the committee on machinery, etc., reported that they had visited Bethlehem, in accordance with the board's orders, and conferred with the expert. That they found that the progress made by him was exceedingly gratifying. Changes in dimensions of presses, cranes, open-hearth furnaces, etc., were then explained in detail.

The building committee, composed of Civil Engineer Endicott and Lieutenant Fletcher, reported that it spent yesterday with Mr. Fritz, the expert, and inspected the plans as far as completed. The plans were in cross section and outline. A few changes in detail that had been authorized were explained.

The board approved the report of the committees and the changes made by them.

The record of minutes since last meeting was read and approved.

The duties of the board during its contemplated trip South were then discussed.

Letters were read and answered from:

Mr. B. F. Fox, Springfield, Ill., making certain inquiries as to when the board's conclusions will be submitted, etc. (File Case A.)

Mr. A. Hinchman, Waco, Tex., concerning the advantages of that place as a site for the proposed armor plant. (File Case A.)

Hon. James Elliott, jr., mayor, Gadsden, Ala., concerning the advantages of that place as a site for the proposed armor plant, and requesting an interview with the board when it reaches Birmingham. (File Case A.)

The president of the board called upon the honorable Secretary of the Navy and reported the progress of work, and informed him of the board's intention to start South on its trip through the Alabama-Tennessee district at 10.43 p. m. to-day, which met with his approval.

Adjourned at 3 p. m.

BIRMINGHAM, ALA., *October 18, 1897.*

Board met at 8 a. m.
Present: All members.
The mayor of Gadsden, Ala., called upon the board and conferred upon the advantages of that place as a site for the proposed armor plant.
At 9 a. m. the board, in company with a committee of the business men of Birmingham, embarked on board a special train. Inspected the Birmingham Rolling Mill and Steel Plant. Witnessed the running of a heat from one of the two 25-ton basic open-hearth furnaces, also the rolling of bars and shapes from the iron puddling furnaces, and the rolling of special thin steel boiler plates.
At 10.30 inspected the Worthington dolomite quarry at Dolcite, 4 miles from the city.
At 11.45. at Point Pleasant, obtained a view of the valley and city of Birmingham, showing some of its principal industrial plants.
At 12 m. inspected the Green Spring mine, an extensive bed of iron ore 2 miles in a direct line from the Alice blast furnaces.
At 12.45 inspected the Spring Gap iron mine, about 5 miles from Bessemer.
At 1.30 saw, in passing, several blast-furnace plants of the Tennessee Coal and Iron Company.
At 2 p. m. inspected the extensive plant of the Howard Harrison Iron Company and the process of making large cast-iron pipes for delivery to many parts of the world.
At 2.30 saw, in passing, the blast-furnace plant of the Woodward Iron and Coal Company.
At 3 p. m. inspected the Ensley furnaces of the Tennessee Coal and Iron Company at Pratt City, and the coke ovens building for the utilization of biproducts.
At 3.45 visited slope No. 4 of the Pratt coal mine.
At 5 p. m. inspected the Thomas furnace of the Pioneer Manufacturing Company.
Returned to Birmingham at 6.30 p. m.
Telegram from the honorable Secretary of the Navy, directing the board to visit Morristown, Tenn., received and answered. (File Case F.)

OCTOBER 19, 1897.

Board met at 10 a. m.
Present: All members.
In company with a committee of representative business men of the district embarked on board of a special train and passed through the mining town of Coalburg at 10.30 a. m.
At 11 a. m. inspected the Brazil Coal mine of the Sloss Steel and Iron Company.
At 12 m. inspected the Blossburg Coal mine of the Sloss Steel and Iron Company; and at 12.45 inspected the West Pratt Coal mine of the Tennessee Coal and Iron Company, at both of which places was witnessed the process of washing the coal for coking purposes.
At 1.45 p. m. inspected the New Birmingham furnace of the Sloss Steel and Iron Company, and at 2.10 saw, in passing, the city furnaces of the same company.
Arrived at Birmingham at 2.30 p. m.
At 4 p. m. a formal meeting of the board was held, at which the experts and managers of iron and steel plants in this district were present and were questioned by the board. All questions were freely answered and all information desired was courteously imparted. The meeting adjourned at 5.30 p. m.
Letters and telegrams received and answered from the following: Hon. F. M. Hight, mayor, Anniston, Ala.; J. C. Byars, secretary and treasurer Board of Trade, Bristol, Tenn.; W. A. Young, chairman Business Men's League, Norfolk, Va.; C. B. Ashe, chairman, Sheffield, Ala.; Hon. B. F. Stubblefield, mayor, Morristown, Tenn. (File Case A.)

SHEFFIELD, ALA., *October 20, 1897.*

Arrived at 8.30 a. m.
At 10 a. m. the board, accompanied by a committee of representative men of Sheffield, took carriages to visit the various points of interest bearing upon the facilities for an armor plant.
At 10.30 a. m. inspected furnaces of the Sheffield Coal, Iron and Steel Company. Witnessed a run of metal and obtained a view of Tuscumbia, part of the Tennessee River, and the surrounding country from an elevated position on one of the furnace stacks.
At 11.45 saw, in passing, the Colbert furnace of the Newcastle Mining and Engineering Company and the frame of a new structure intended for a rolling mill.
At 12.15 p. m. inspected the water front of the Tennessee River, where pig iron is loaded for cheap shipment north and south, and obtained a view of the town of Florence.

At 12.30 p. m. a formal meeting was held, at which papers were read and submitted concerning the advantages of Sheffield by the following: Mr. J. C. Harris, president of the City Company; Hon. Thomas R. Roulhac, circuit judge of Alabama; Mr. James C. Foster, chemist of Sheffield Coal and Iron Company; Maj. A. W. Wills, president of Sheffield Coal and Iron Company.

Additional information was obtained by the board through questions propounded, which were freely and courteously answered.

Addresses were also made by Hon. Joseph Wheeler, M. C.; Hon. J. Wesley Gaines, M. C.; Hon. E. W. Carmack, M. C.

After a brief reply to the men of Sheffield there present by the president of the board the meeting adjourned at 4.30 p. m.

Upon the earnest solicitation of Hon. J. Wesley Gaines, M. C., and other representative men of the South, the board decided to accept an invitation to visit the Tennessee Centennial Exhibit, at Nashville, Tenn.. and there view the mineral and other resources of the South bearing upon the production of armor in this section.

Letter received and answered from Hon. L. S. Freeman, Harriman, Tenn. (File Case A.)

NASHVILLE, TENN., *October 21, 1897.*

At 10.30 a. m. the board was escorted to the Tennessee Centennial Exhibition by the Hon. J. W. Gaines, M. C., and a committee of representative business men, and there examined the vast exhibits of iron ore, coal, limestone, and other minerals from many sections of the South. Saw also numerous exhibits of iron, steel, and other products of Southern industry, and many other exhibits illustrative of the vast resources and transportation facilities of this section.

A telegram was received and answered from Mr. C. W. Woodbury, Middlesboro, Ky. (File Case A.)

CHATTANOOGA, TENN., *October 22, 1897.*

At 9 a. m. a committee of gentlemen representing the Chamber of Commerce of Chattanooga met the board and escorted the members to the various points of industrial and national interest.

At 10 a. m. visited Orchard Knob, after which drove along Missionary Ridge and across the Chattanooga Valley, arriving at Lookout Mountain at 1 p. m.

At 3.45 p. m. a formal meeting was held in presence of the representative men of Chattanooga, at which a paper was read on the resources and advantages of Chattanooga as a site for the proposed armor factory, by Capt. H. S. Chamberlain, president of the Cilico Furnace Company and of the Roane Iron Company. Questions were propounded by the board and freely answered. Addresses were also made by the Hon. Benton McMillin, M. C., and Hon. Willard Warner on the advantages of this section, after which the meeting adjourned at 4.45 p. m.

Left Chattanooga at 6.15 p. m.

KNOXVILLE, TENN., *October 23, 1897.*

At 8.15 a. m. the board was conducted in a special car, by a committee of representative men from the Chamber of Commerce, on a tour of inspection by the Belt Line around the city, through the region available for and partially occupied by industrial plants, and afterwards in carriages through the city.

At 11 a. m. the board met the gentlemen of the Chamber of Commerce at their room in the city, where an address upon the resources and advantages of the locality as a site for the proposed armor plant was delivered by the Hon. S. G. Heiskell, mayor of Knoxville, and papers containing data upon the same subject were formally presented to the board.

The meeting adjourned at 11.45 a. m., and the board left Knoxville at 12.15 p. m.

MORRISTOWN, TENN.

Arrived at 1.15 p. m. and immediately took a train, in company with a number of representative business men, on the Cumberland Gap Railroad, where several available sites for the location of the proposed armor plant on the banks of the Tennessee River were inspected.

Upon returning to the town at 2.20 p. m., the board was accompanied by the same gentlemen during a drive of inspection through the valley.

From 4 p. m. to 4.45 p. m. a formal meeting was held, during which questions were propounded by the board to be answered later through the mail. Addresses were delivered by Mr. J. B. Holloway, ex-mayor and lawyer; C. H. Darlington, editor; Col. T. H. Reeves, U. S. A., retired, water commissioner; Mr. J. R. King-attorney at law; Dr. G. B. F. Dice, Mr. B. F. Stubblefield, and Mr. W. S. Dick, son, ex-mayor and attorney at law.

Left Morristown at 5.55 p. m.

ELIZABETHTON, TENN., *Sunday, October 24, 1897.*

At 9.15 a. m. left the town in company with a number of representative business men on board a train of the East Tennessee and Western North Carolina Railroad, passing through a region abounding in iron ore and limestone, and arriving at Cranberry, N. C., at 11 a. m.

Inspected the Cranberry Iron Mine and the blast furnace property of the Cranberry Iron Company.

Dined at the Cranberry Inn.

Returned to Elizabethton, Tenn., at 3.30 p. m.

OCTOBER 25, 1897.

At 9 a. m. inspected the beautiful Watauga Valley and several sites recommended for the proposed armor factory.

At 11 a. m. a formal meeting was held with the Board of Trade, at which a paper on the resources and advantages of Elizabethton was read by Judge H. M. Folsom.

Questions were left with the Board of Trade, to be answered by mail, and the meeting adjourned at 11.30 a. m.

The board was here visited by a committee of the Board of Trade of Bristol, Tenn.-Va., led by the mayor, Mr. J. H. Winston, requesting the board to visit that place.

Left Elizabethton, Tenn., at 11.45 a. m., and arrived at Bristol, Tenn.-Va., at 1.30 p. m.

BRISTOL, TENN.-VA.

Inspected the blast furnace of the Bristol Iron and Steel Company, and in company with the Board of Trade visited various points of interest in the city.

At 3 p. m. the board attended a meeting of the Bristol Board of Trade, at which a paper on the resources and advantages of Bristol was read by Mr. J. C. Byars, secretary.

Questions were left with the Board of Trade, to be answered by mail. The meeting adjourned at 3.45 p. m.

Left Bristol at 9.15 p. m. to return to Washington via Morristown, Tenn., and Asheville, N. C., on the Southern Railway, with which arrangements had been made for the entire trip.

WASHINGTON, D. C., *October 27, 1897.*

Arrived in Washington at 8.30 a. m.

Board met at 11 a. m.

Present: All the members.

Minutes read and approved.

The president of the board called upon the honorable Secretary of the Navy and reported the return of the board. The Secretary of the Navy authorized a temporary adjournment of the board, the committees to proceed with the preparation of plans in the same manner as before their departure from Washington.

Letters were read and answered from the following (File Case A):

Hon. W. F. Young, M. C., and others, inviting the board to visit Norfolk, Portsmouth, Va., and vicinity.

Jesse Overstreet, esq., requesting the board to visit Indianapolis, Ind.

Hon. J. C. Spooner, U. S. S., requesting the board to visit the Head of the Lakes.

Mr. G. S. McFadden, requesting the board to visit Moundsville, W. Va.

Hon. John J. Jenkins, M. C., requesting the board to visit West Superior and Duluth, Wis.

Mr. Edward S. Tyler, concerning the advantages of Anniston, Ala.

Mr. Thomas Clifford, concerning the advantages of Claremont, Surry County, Va.

The board adjourned at 1 p. m. to meet again formally at 1 p. m. on Wednesday, November 3.

At 3 p. m. Mr. Albert B. Seip called on behalf of the "Head of the Lakes United States Armor Plate Committee," and was informed that it would be impossible for the board to make any more visits of location prior to submitting its report on December 1.

OCTOBER 29, 1897.

Letters received and answered from:

Hon. Edward S. Tyler, Anniston, Ala. (File Case A.)

Mr. A. C. Isaacs, the Coronet Steel Company, West Hoboken, N. J. (File Case E.)

Letter sent to Mr. A. S. Buford, Richmond Chamber of Commerce, appointing a date to receive the Committee from that city. (File Case A.)

NOVEMBER 1, 1897.

Letter sent to Mr. F. Firmstone, Easton, Pa.
Letter received and answered from Mr. D. B. Atherton, secretary Board of Trade, Scranton, Pa. (File Case A.)

NOVEMBER 2, 1897.

Letters sent to Mr. John Fritz, Bethlehem, Pa.; Hon. O. W. Underwood, M. C., Birmingham, Ala.; the Morgan Engineering Company, Alliance, Ohio.
Letter received and answered from the Wm. Sellers Company (Incorporated), Philadelphia, Pa. (File Case C.)

NOVEMBER 3, 1897.

Board met at 1 p. m.
Present: All the members.
A committee from the Richmond Chamber of Commerce appeared to lay before the board certain data concerning the advantages of Richmond as a site for the proposed armor plant. A paper on the subject was read by Col. A. S. Buford, chairman of the committee, and addresses were made by Mr. W. R. Trigg, president of the Richmond Locomotive and Machine Works; by Mr. A. B. Clarke, president of the Old Dominion Iron and Nail Works, and by Hon. John Lamb, M. C., representing the Third Congressional district of Virginia.
A report was made by Chief Engineer Perry upon the progress made on plans by Mr. John Fritz and his draftsmen at Bethlehem, and upon the state of estimates by the Wm. Sellers Company, Bement, Miles & Co., and the Morgan Engineering Company.
Board discussed the question of estimates.
Letters were received and answered from Mr. W. B. Dennis, through Hon. J. L. Wilson, United States Senate, concerning Port Townsend, Wash., as a site for the proposed armor plant (File Case A), and Mr. A. C. Isaacs, the Coronet Steel Company, West Hoboken, N. J., concerning his process for making steel. (File Case E.)
A letter was sent to Mr. M. V. Richards, expressing the thanks of the board to Mr. W. W. Finley and other officers of the Southern Railway for the facilities rendered by them to the board during its recent trip through the South.
Adjourned at 3.30 p. m., to meet to-morrow at 10.30 a. m.

NOVEMBER 4, 1897.

Board met at 10.30 a. m.
Present: All the members.
Minutes read and approved.
Agreed to file for use when called for all the information collected by the board on the subject of resources, etc., during the recent trip through the Alabama-Tennessee district, and all other information of the same character received by the board from other parts of the country.
Letters received and answered from Bement, Miles & Co., concerning estimates on machine tools. (File Case C.)
The board decided to send the committee on machine tools, etc., and the committee on buildings, etc., to Bethlehem to expedite the preparation of the plans of the armor factory and to proceed with the estimates and specifications for the component parts of such factory, these committees to report progress at the next meeting of the board.
Agreed to adjourn after this meeting until November 22, at which time all committees shall have their work ready to submit to the full board in as complete a state as possible. Should a meeting of the full board be deemed necessary before that date it will be called by the president.
The president of the board then called upon the honorable Secretary of the Navy and reported the progress of the work done by the board, which met with his approval.
After a brief discussion on the subject of estimates the board took a recess at 12 m.

AFTER RECESS.

Reconvened at 1.30 p. m.
Discussed the subject of estimates.
Adjourned at 3.30 p. m.

NOVEMBER 5, 1897.

Letters received and answered from (File Case A):

Dr. William B. Phillips, concerning analyses of steel made from Birmingham ores.

Mr. F. Firmstone, concerning analyses of Cranberry iron ores.

Hon. G. W. Steele, M. C., concerning a request for the board to visit Marion, Ind.

Mr. Parke L. Poindexter, concerning the advantages of St. Helena, Norfolk County, Va., as a site for the proposed armor plant.

Orders were received for Capt. A. H. McCormick to report at the Navy Department on November 6, as a member of a board to consider the reorganization of the personnel of the Navy. This in addition to his present duties.

NOVEMBER 6, 1897.

Letter received and answered from Mr. R. A. Dunlop, secretary Chamber of Commerce, concerning a letter in regard to the advantages of Richmond, Va. (File Case A.)

NOVEMBER 8, 1897.

Letters received and answered from:

Bement, Miles & Co., concerning estimates on heavy machine tools. (File Case C.)

Mr. Charles Darlington, concerning a report on the advantages of Morristown, Tenn., as a site for the proposed armor plant. (File Case A.)

Mr. H. S. Chamberlain, Chattanooga, Tenn., concerning the analyses of coke, iron, and steel from Tennessee mines. (File Case A.)

Telegram received from Chief Engineer Perry and answered concerning estimates forwarded to Bethlehem, Pa.

NOVEMBER 10, 1897.

Letters sent to Riehle Bros. and to the Wm. Sellers Company, concerning estimates on machine tools.

Letter received and answered from the Detrich & Harvey Machine Company, Baltimore, Md. (File Case C.)

NOVEMBER 12, 1897.

Letters received and answered from:

Judge Thomas F. Roulhac, Sheffield, Ala., concerning an address on the resources of Sheffield. (File Case A.)

The Wm. Sellers Company, Philadelphia, Pa., concerning estimates for machine tools. (File Case C.)

NOVEMBER 13, 1897.

Letters received and answered from:

Mr. Lee F. Miller, president board of trade, concerning a supplemental report on the advantages of Elizabethton, Tenn. (File Case A.)

Hon. O. W. Underwood, M. C., concerning information in regard to the industries of Birmingham, Ala. (File Case A.)

NOVEMBER 15, 1897.

Letters received and answered from:

Mr. F. M. Myers, concerning a mine of molybdenum in Colorada. (File Case A.)

The Riehle Bros., Philadelphia, Pa., concerning estimates for machine tools. (File Case C.)

NOVEMBER 16, 1897.

Letters received and answered from Mr. C. M. Woodbury, vice-president Business Association, concerning the advantages of Middlesboro, Ky. (File Case .A)

NOVEMBER 17, 1897.

Letter received and answered from Mr. C. M. Woodbury, concerning report on Middlesboro, Ky., sent to the honorable Secretary of the Navy. (File Case A.)

NOVEMBER 18, 1897.

Telegram sent to Civil Engineer Endicott, at Bethlehem, Pa., concerning change in date of next formal meeting.

Letter received and answered from Hon. S. B. Elkins, U. S. S., concerning an inquiry about the report of the armor factory board. (File Case A.)

NOVEMBER 19, 1897.

Letter received and answered from W. H. Morgan, vice-president the Morgan Engineering Company, Alliance, Ohio, concerning estimates on electric overhead-traveling cranes. (File Case C.)

NOVEMBER 20, 1897.

Letters received and answered from:

Hon. J. W. Gaines, M. C., concerning the stenographic report of the meeting of the board with manufacturers of Birmingham. (File Case A.)

Mr. J. M. Schoolbred, manager of the Watauga Land Company, Elizabethton, Tenn., concerning analyses of dolomite used in the Cranberry furnace. (File Case A.)

NOVEMBER 23, 1897.

Letters received and answered from Mr. M. V. Richards, land and industrial agent Southern Railway, and Mr. L. S. Freeman and others, Harriman, Tenn., forwarding information concerning the advantages of Harriman, Tenn., as a site for the proposed armor plant. (File Case A.)

A cabinet containing specimens of coal, coke, and iron ore was received from Harriman, Tenn.

NOVEMBER 24, 1897.

A committee of representative men from Orange, N. J., called upon the board and were supplied with information concerning the scope of this report.

NOVEMBER 26, 1897.

Board met at 1 p. m.

Present: All the members.

Minutes read and approved.

The committees on machiney, etc., and on buildings, etc., reported progress. These reports showed that it would be possible to complete the report of the board by December 1.

The rough draft of the board's report as far as prepared was read, discussed, and revised where deemed advisable.

Adjourned at 4 p. m. until to-morrow at 1 p. m.

NOVEMBER 27, 1897.

Letters received and answered from:

Hon. W. D. B. Alexander, chairman of committee, Chamber of Commerce, Cleveland, Ohio, and Hon. T. E. Burton, M. C., requesting board to visit Cleveland. (File Case A.)

Hon. William C. Maybury, mayor, Detroit, Mich., concerning the advantages of that city as a site for the proposed armor plant. (File Case A.)

James P. Wise, president, the West Norfolk Land Improvement Company, West Norfolk, Va., concerning the advantages of Craney Island and West Norfolk, Va. (File Case A.)

Mr. L. S. Freeman, Harriman, Tenn., and Mr. M. V. Richards, concerning a map of coal lands in the vicinity of Harriman. (File Case A.)

Board met at 1 p. m.

Present: All the members except Civil Engineer Endicott, who was absent by order of the Navy Department on special duty at Annapolis.

The report as revised was read and discussed.

Letter sent requesting Mr. John Fritz to meet the board at 2 p. m. on November 30.

Board adjourned at 4 p. m. to meet on Monday, November 29, at 1 p. m.

NOVEMBER 29, 1897.

Board met at 1 p. m.

Present: All the members.

Discussed arrangement of the board's report, and decided to submit the details of estimates in the form of an appendix.

Letters received and answered from:

F. W. Edmunds, secretary Troy Steel Company, concerning the advertisement for proposals. (File Case A.)

Mr. John Fritz, concerning estimates and drawings. (File Case C.)

Adjourned at 3 p. m. to meet to-morrow, Tuesday, November 30, at 1 p. m.

NOVEMBER 30, 1897.

Board met at 1 p. m.
Present: All the members.
The board's report was finally considered, and it was agreed to meet to-morrow at 12 o'clock noon to sign it. Ordered that the report and all appendixes be ready for transmittal to the honorable Secretary of the Navy by that time.
Mr. John Fritz appeared at the request of the board and had a conference with the board in regard to the report and estimates.
Letters were read and answered from:
W. H. Chace, secretary of the armor plate plant committee of the Toledo Chamber of Commerce, requesting copies of specifications. (File Case A.)
Mr. J. J. Sullivan, concerning a tender of land and the advantages of Flomaton, Ala., for purposes of a Government armor factory. (File Case A.)
Mr. W. G. Armstrong, Whitworth & Co., Limited, Manchester, England, concerning estimates on large machine tools. (File Case C.)
Col. A. W. Wills, concerning data furnished regarding the Sheffield iron industry. (File Case A.)
Board adjourned at 3.30 p. m. to meet to-morrow at 12 m.

DECEMBER 1, 1897.

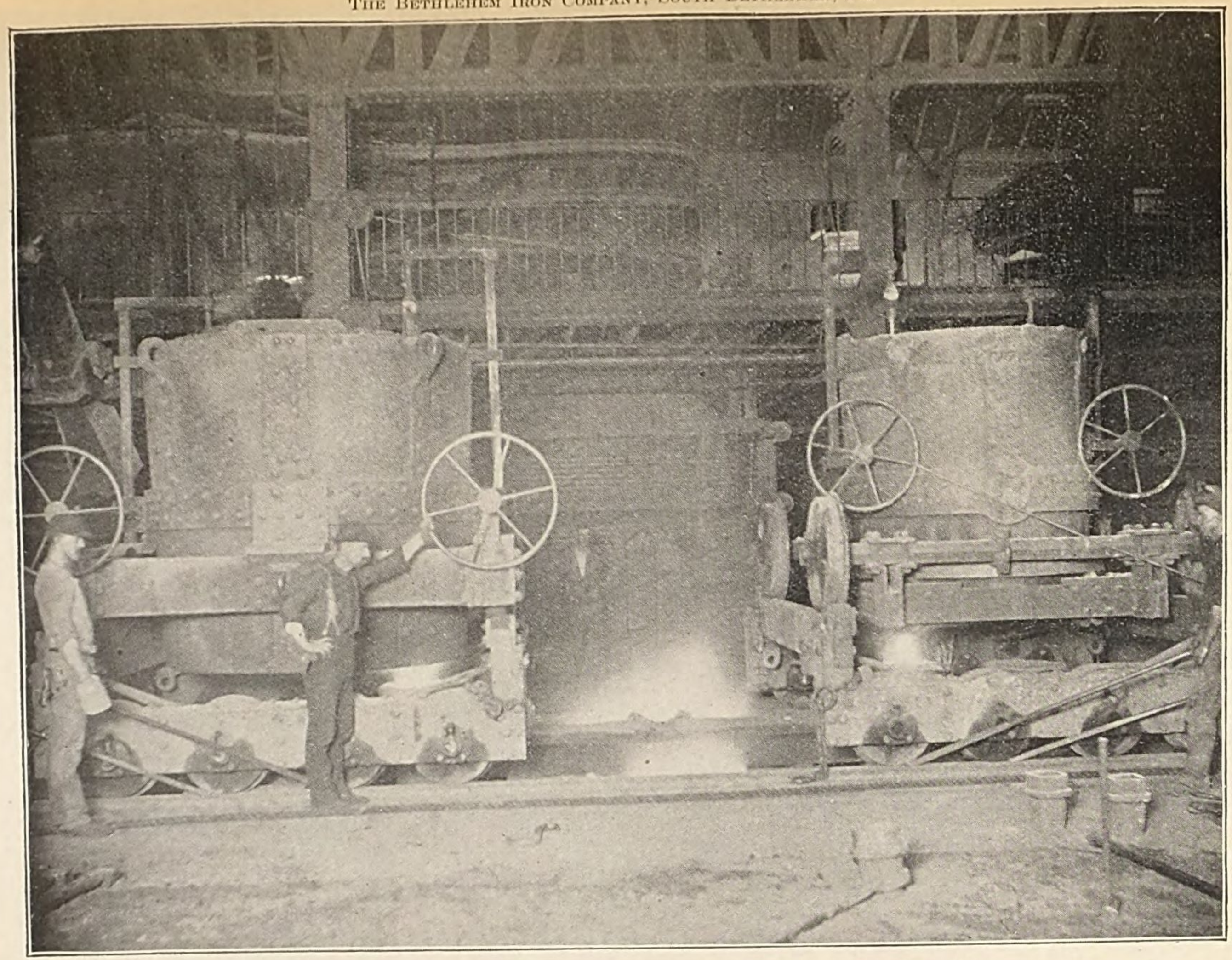
Board met at 12 m.
Present: All the members.
Minutes read and approved.
The report was signed and together with all the appendixes was delivered to the honorable Secretary of the Navy.
The appendixes to this report are as follows:
Appendix A.—Drawings, 38 in number.
Appendix B.—Specifications.
Appendix C.—Details of estimates.
Appendix D.—List of places recommended to the board as sites.
Appendix E.—Form of advertisement for proposals.
Appendix F.—Record of proceedings.
Appendix G.—Photographs.
A true record:

W. IRVING CHAMBERS,
Lieutenant, U. S. N., Recorder Armor Factory Board.

APPENDIX G.

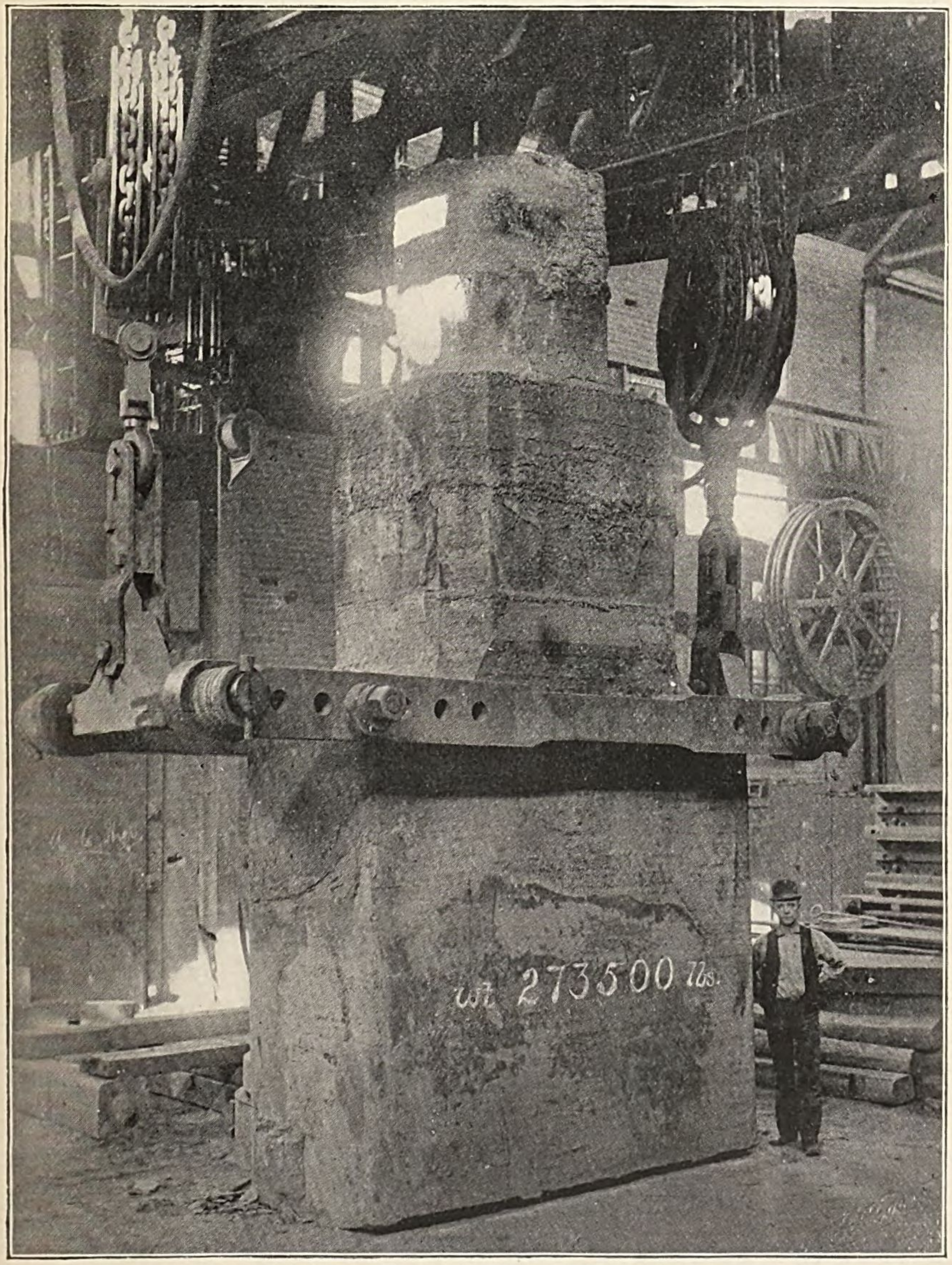
(39 illustrations.)

ARMOR FACTORY OF THE BETHLEHEM IRON COMPANY, SOUTH BETHLEHEM, PA.

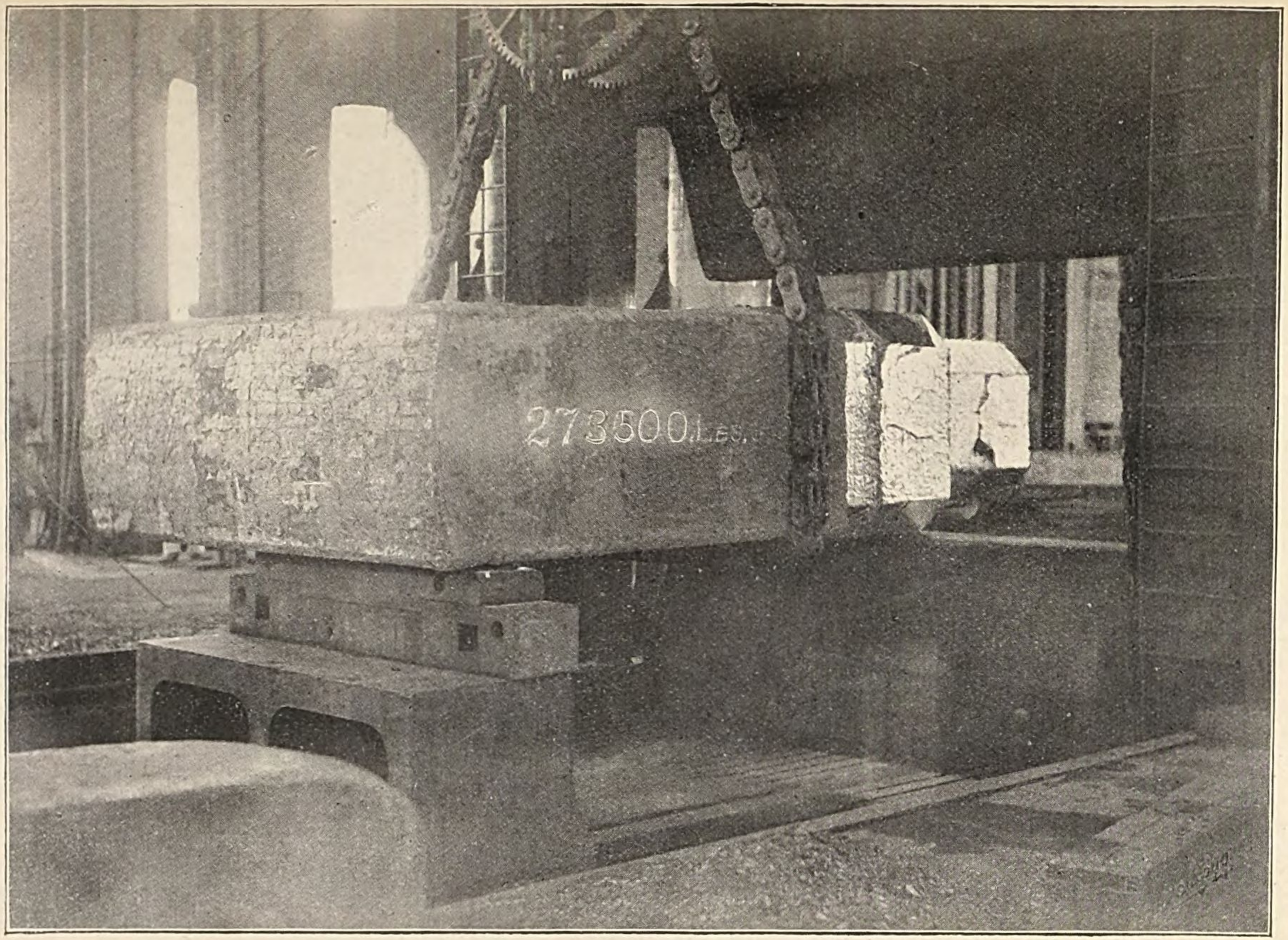


AT OPEN-HEARTH FURNACES. CASTING AN 80-TON ARMOR-PLATE INGOT.

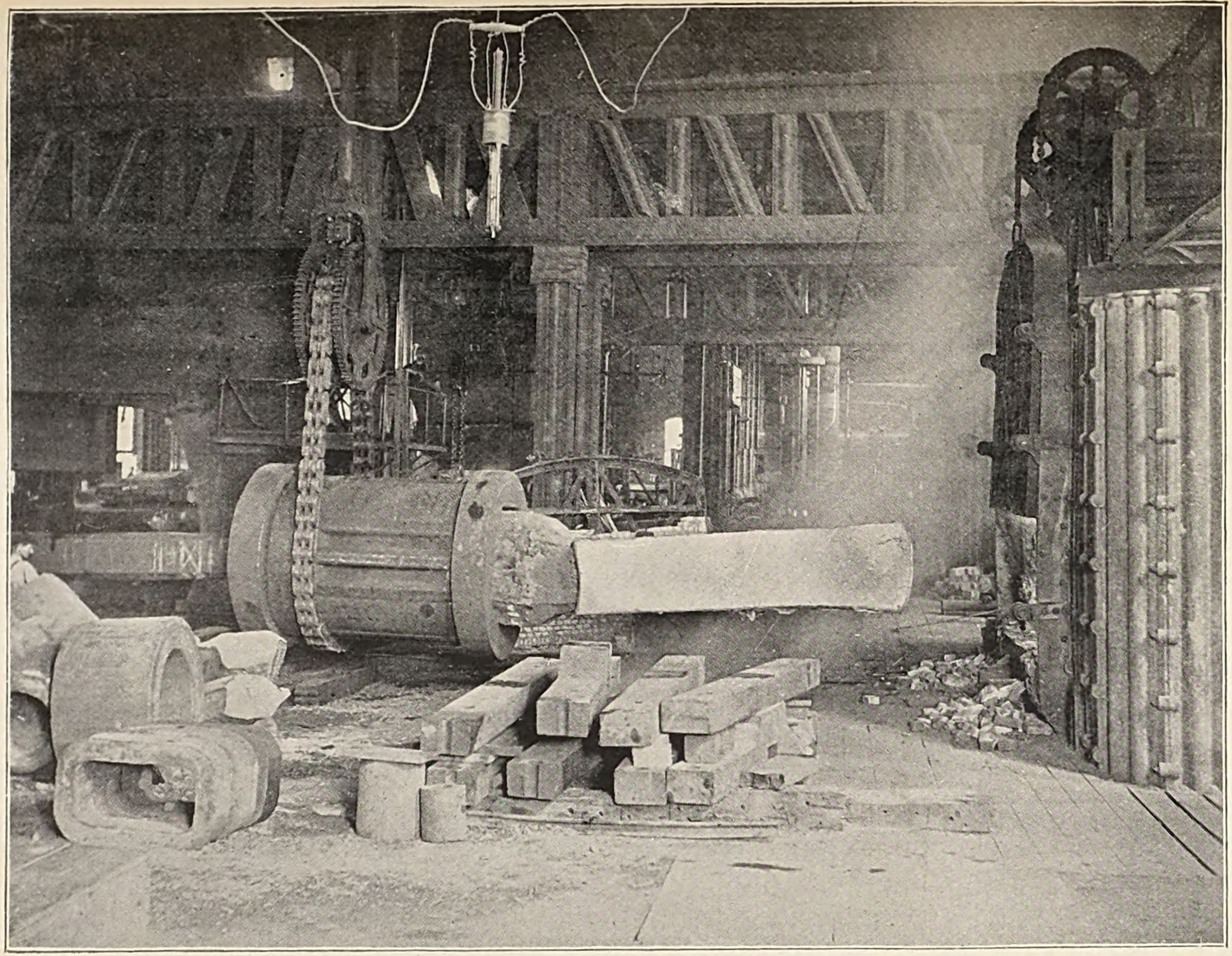
THE BETHLEHEM IRON COMPANY, SOUTH BETHLEHEM, PA.



NICKEL-STEEL ARMOR-PLATE INGOT.

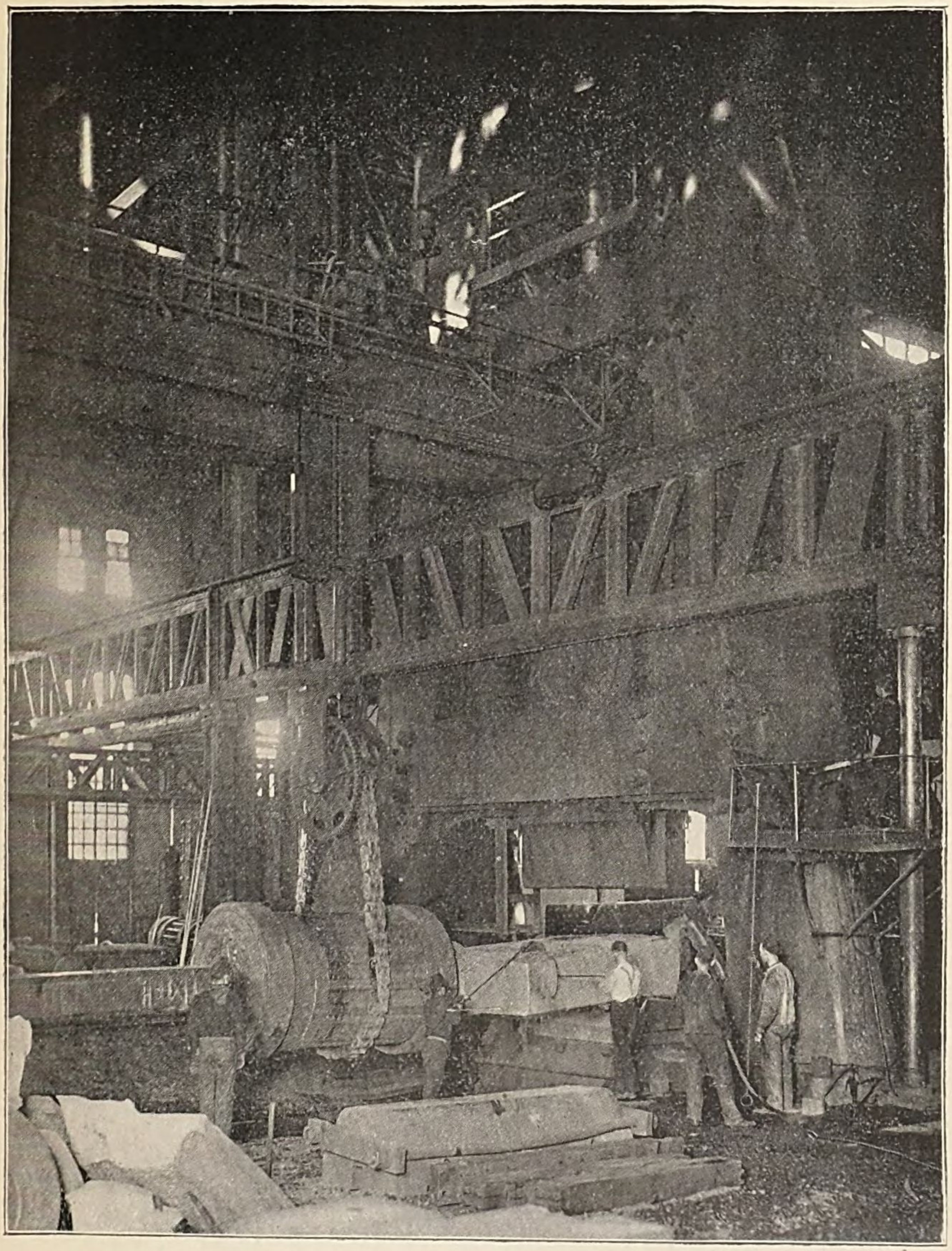


ARMOR-PLATE INGOT UNDER FORGING PRESS.



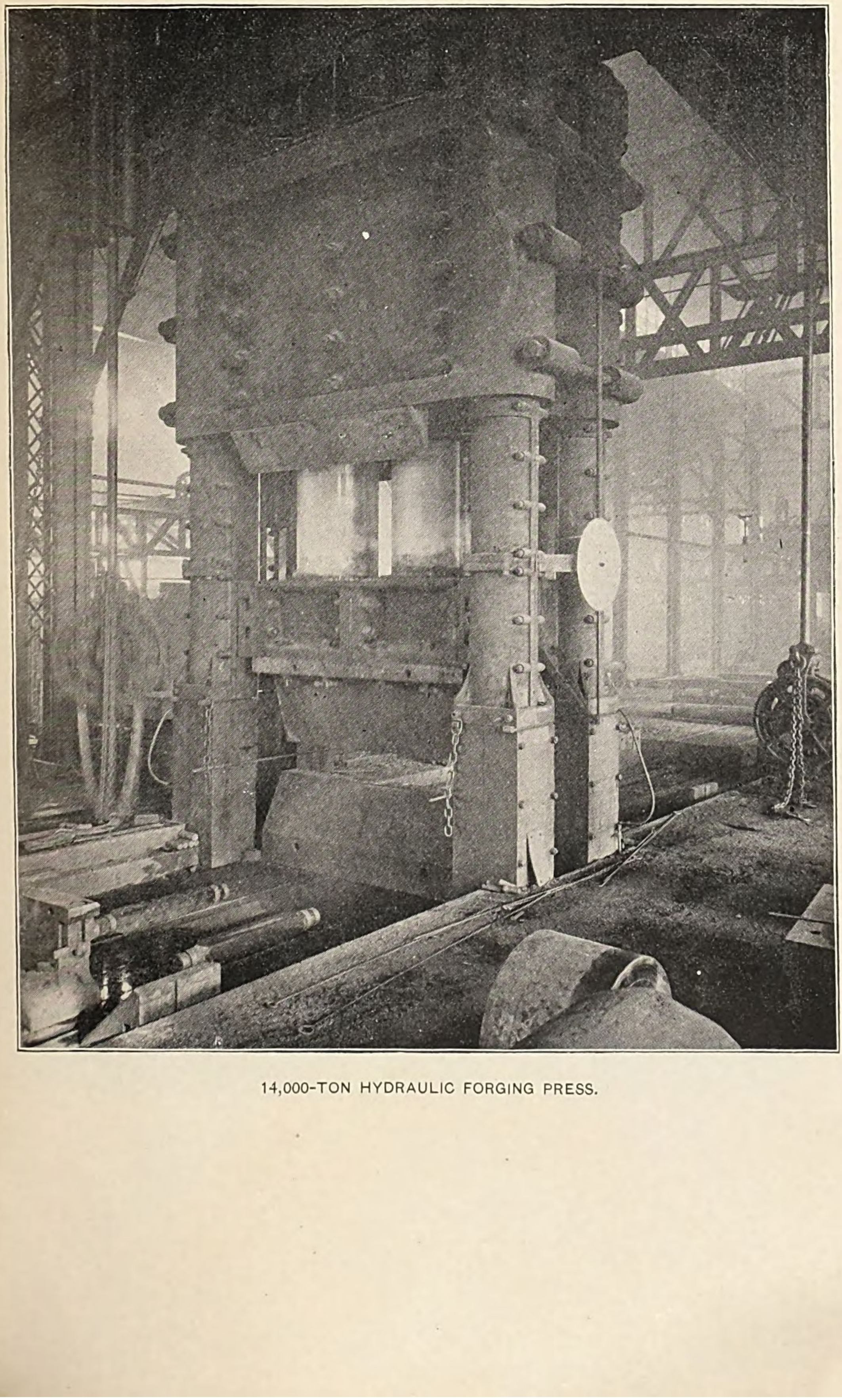
75-TON NICKEL-STEEL INGOT BEING TAKEN FROM HEATING FURNACE.

THE BETHLEHEM IRON COMPANY, SOUTH BETHLEHEM, PA.

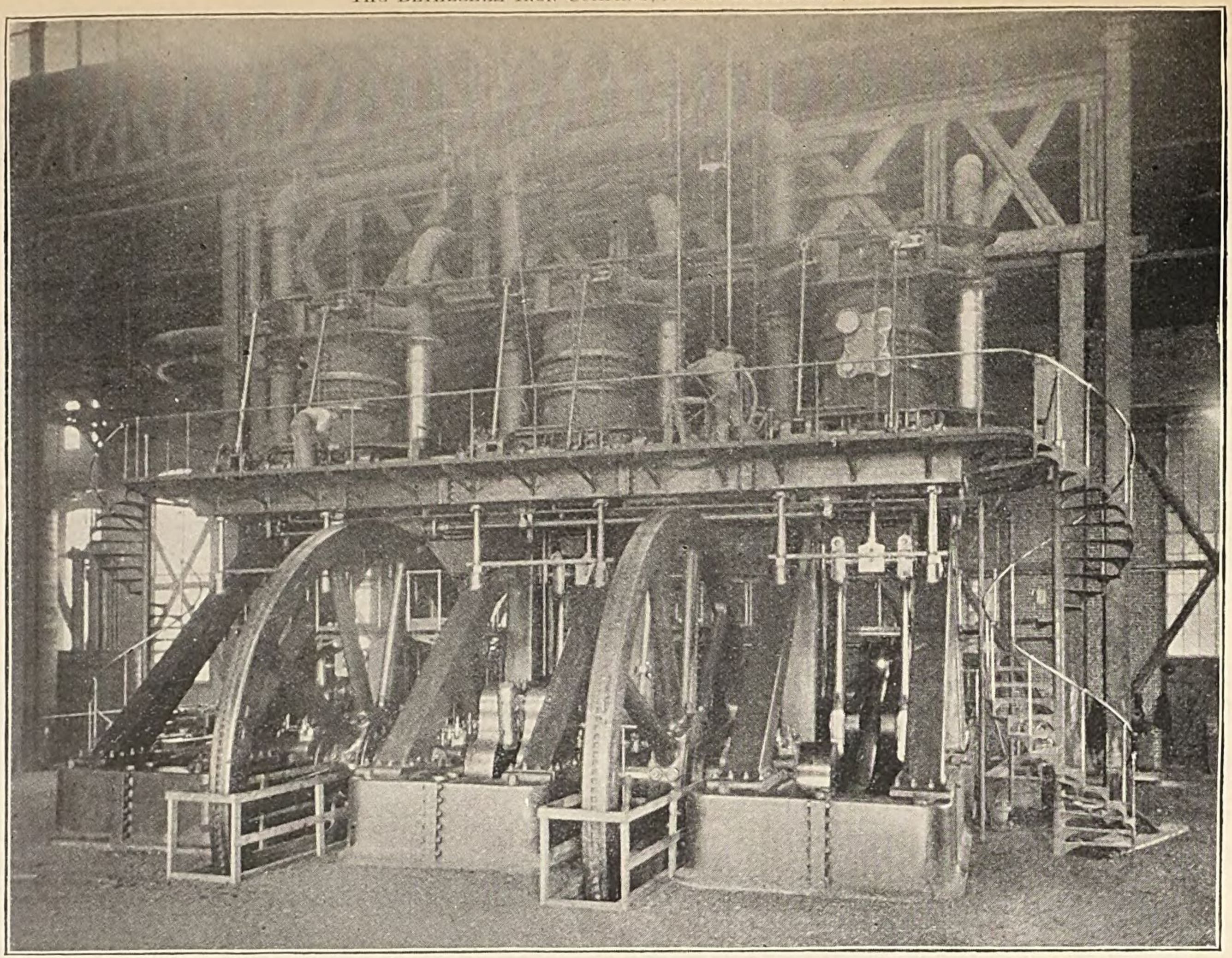


FORGING AN ARMOR PLATE 17 INCHES THICK.

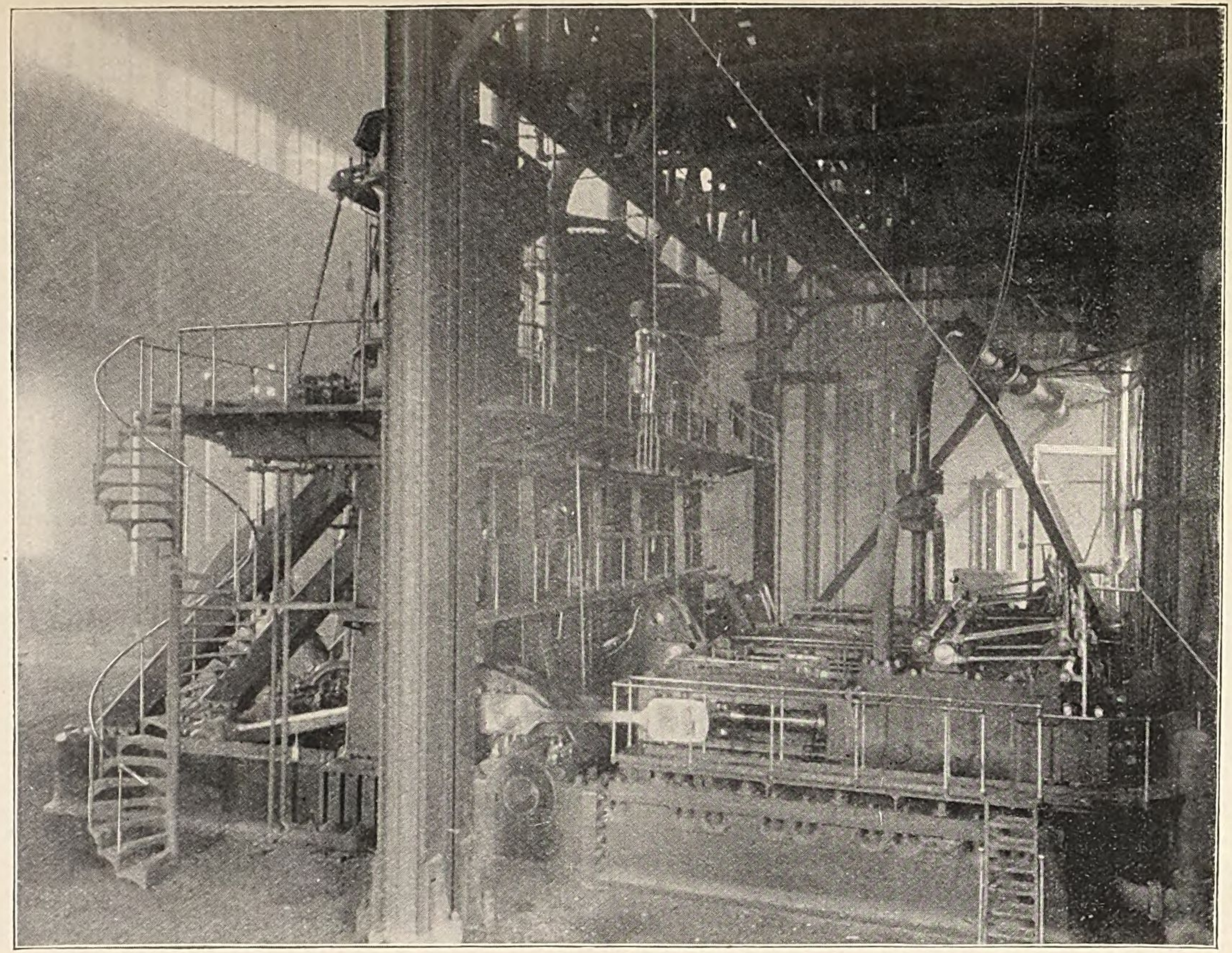
THE BETHLEHEM IRON COMPANY, SOUTH BETHLEHEM, PA.



14,000-TON HYDRAULIC FORGING PRESS.

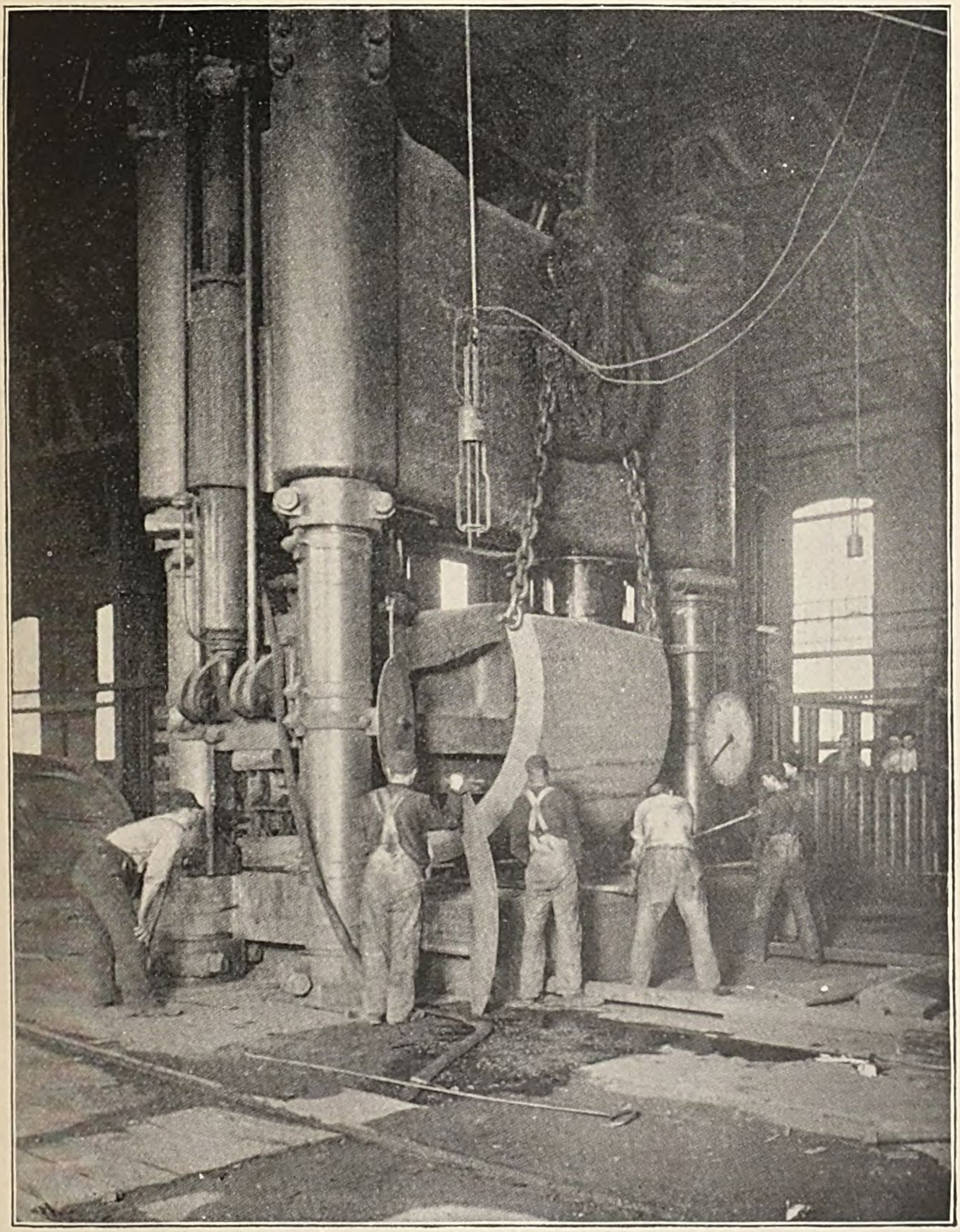


FORGE PRESS ENGINE (15,000 HORSE POWER).

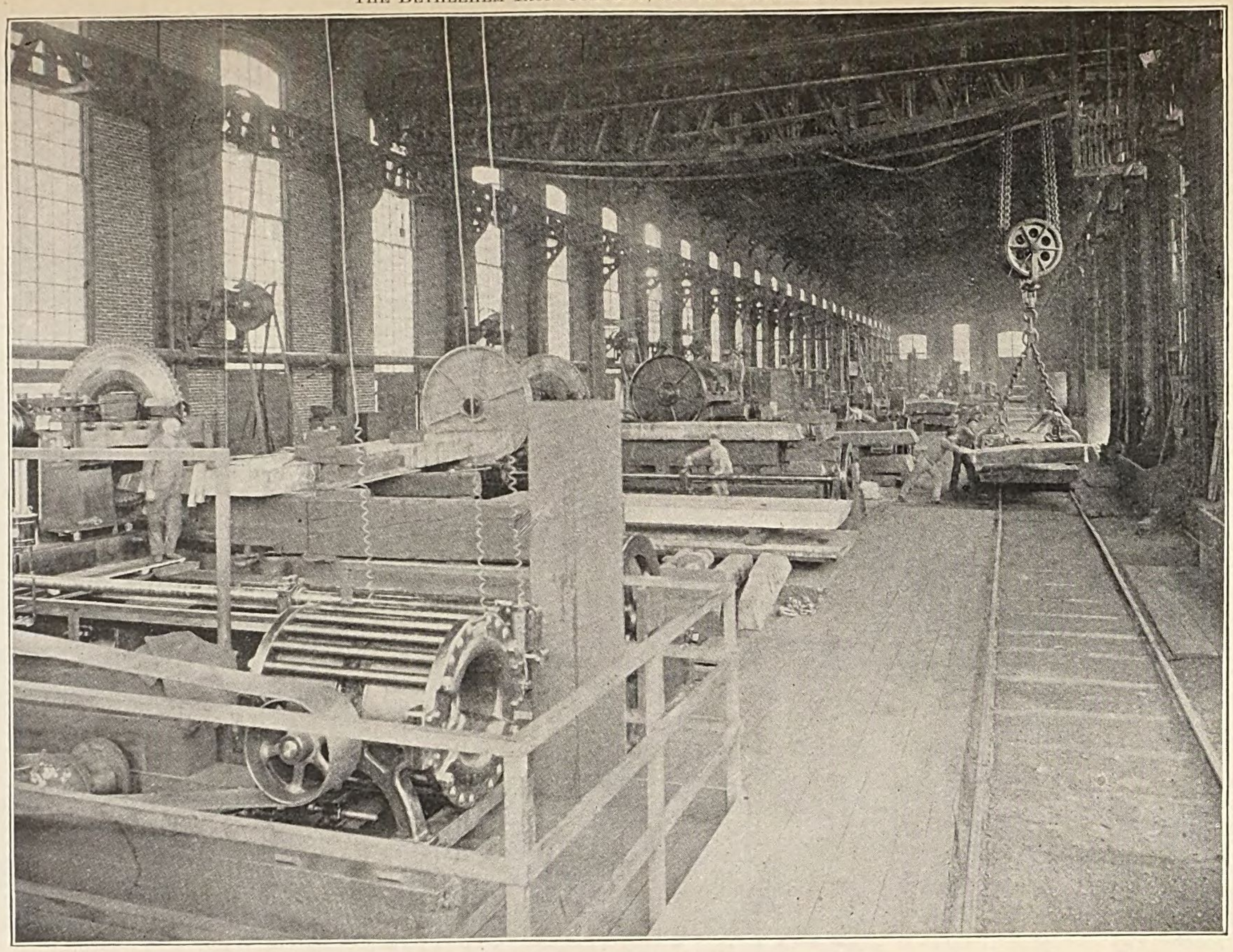


FORGE PRESS ENGINE (SIDE VIEW).

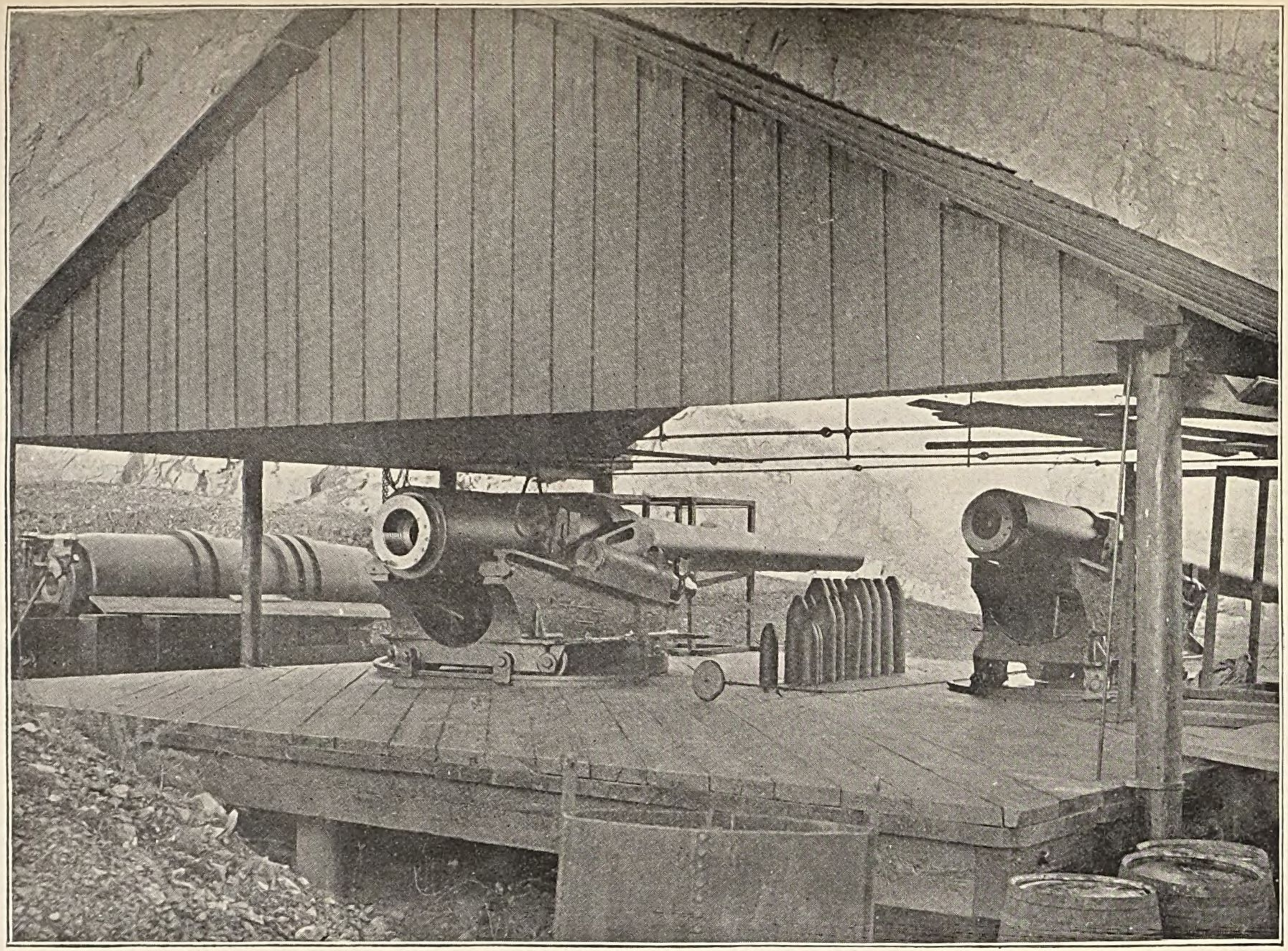
THE BETHLEHEM IRON COMPANY, SOUTH BETHLEHEM, PA.



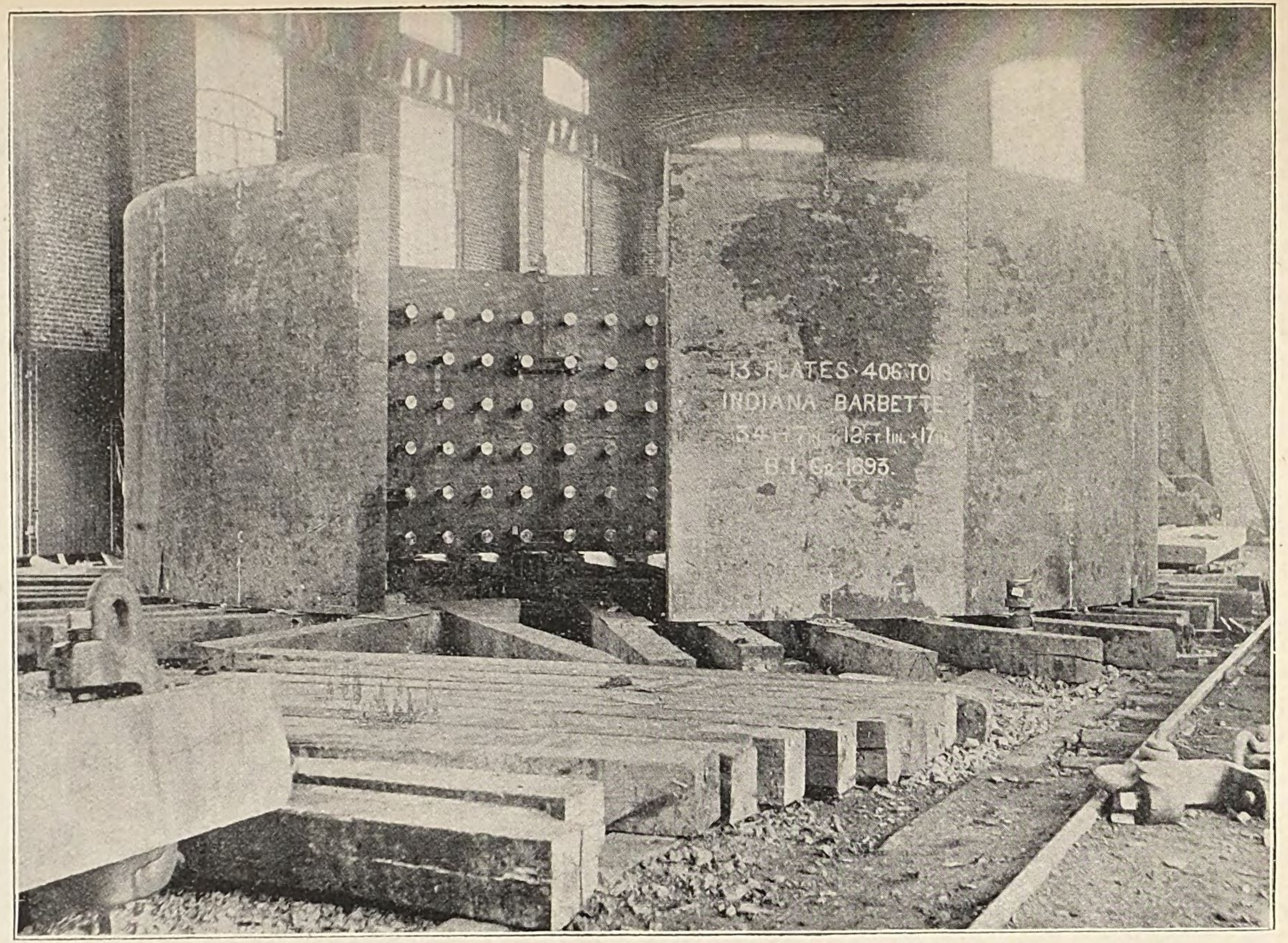
BENDING PRESS. BENDING AN ARMOR PLATE 8 INCHES THICK.



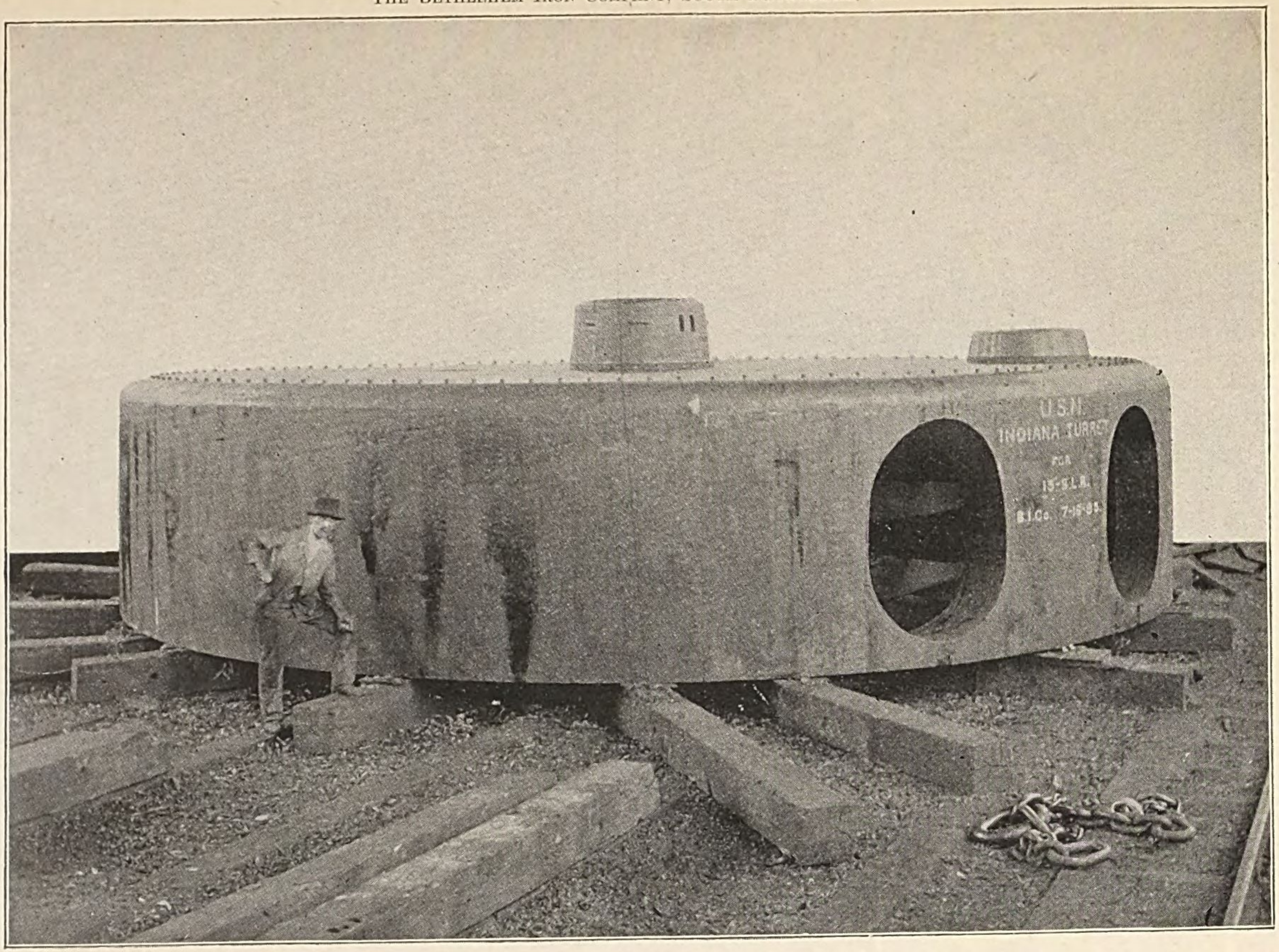
ARMOR-PLATE MACHINE SHOP.



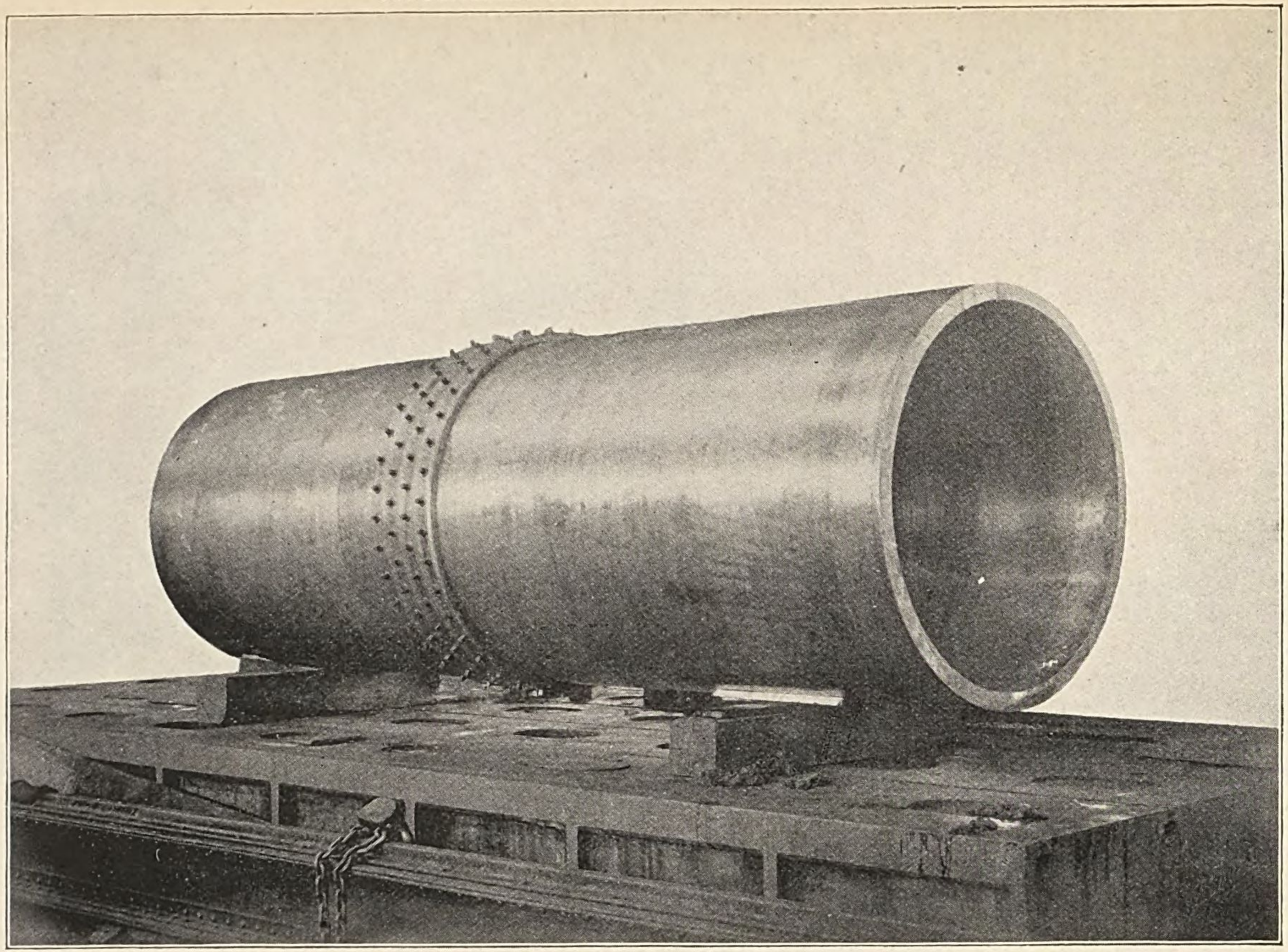
BATTERY AT PROVING GROUND, REDINGTON, PA.



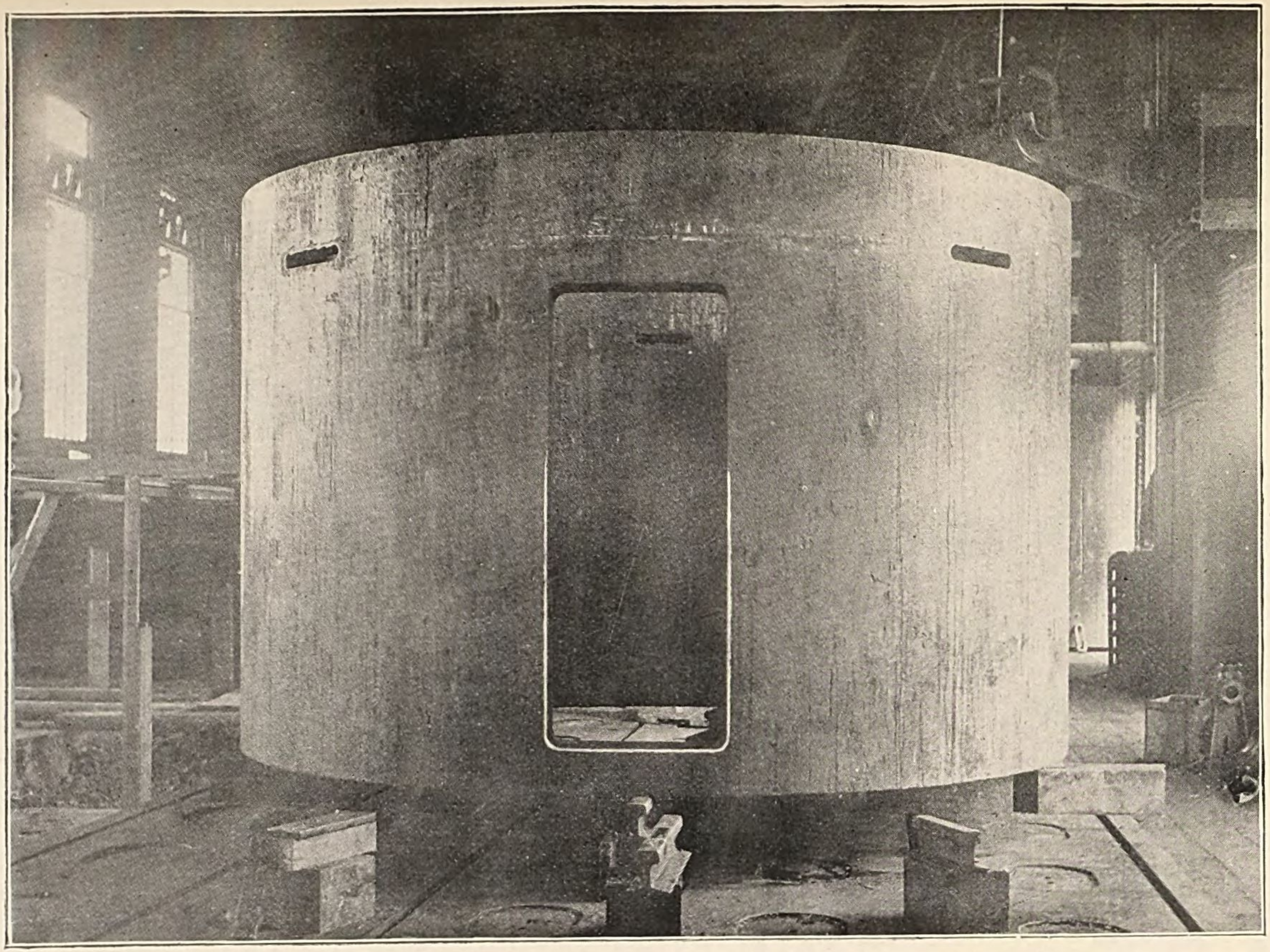
ARMORED BARBETTE WITH ONE PLATE REMOVED.



ARMORED GUN TURRET, PLATES 15 INCHES THICK.



ARMORED AMMUNITION TUBE (FORGED HOLLOW IN TWO LENGTHS).

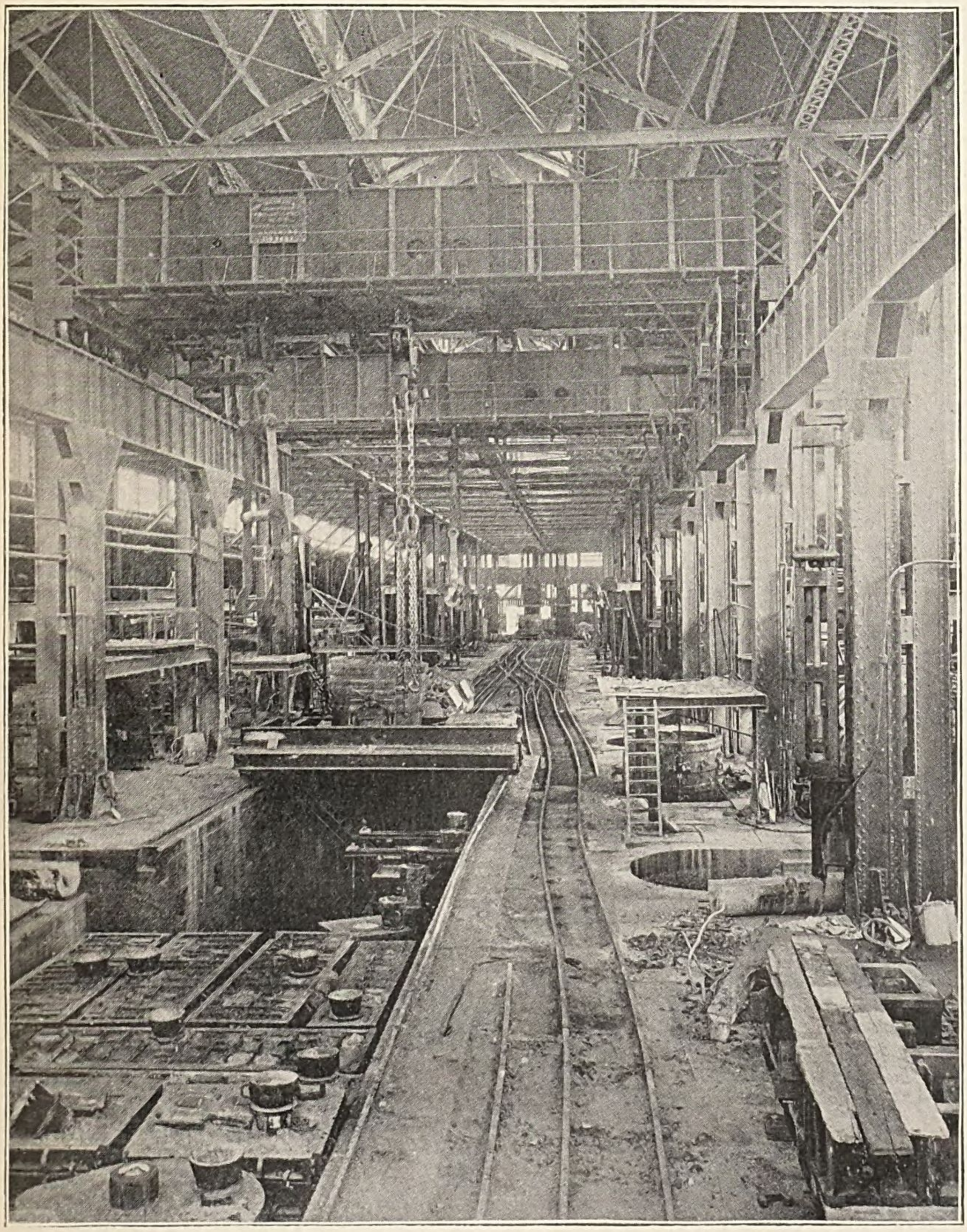


CONNING TOWER. FORGED IN ONE PIECE.

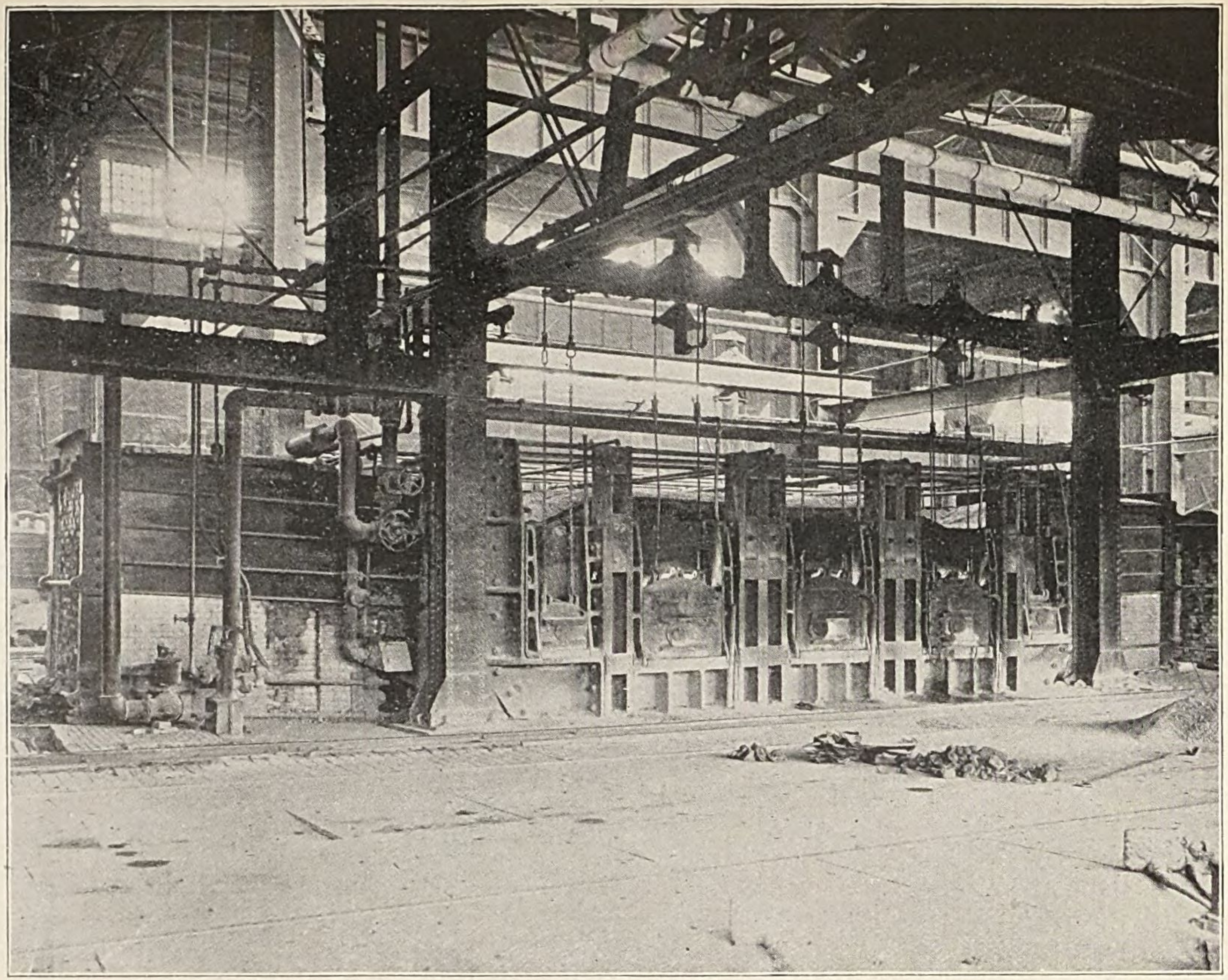
ARMOR FACTORY OF THE CARNEGIE STEEL COMPANY, MUNHALL, PA.

"HOMESTEAD WORKS."

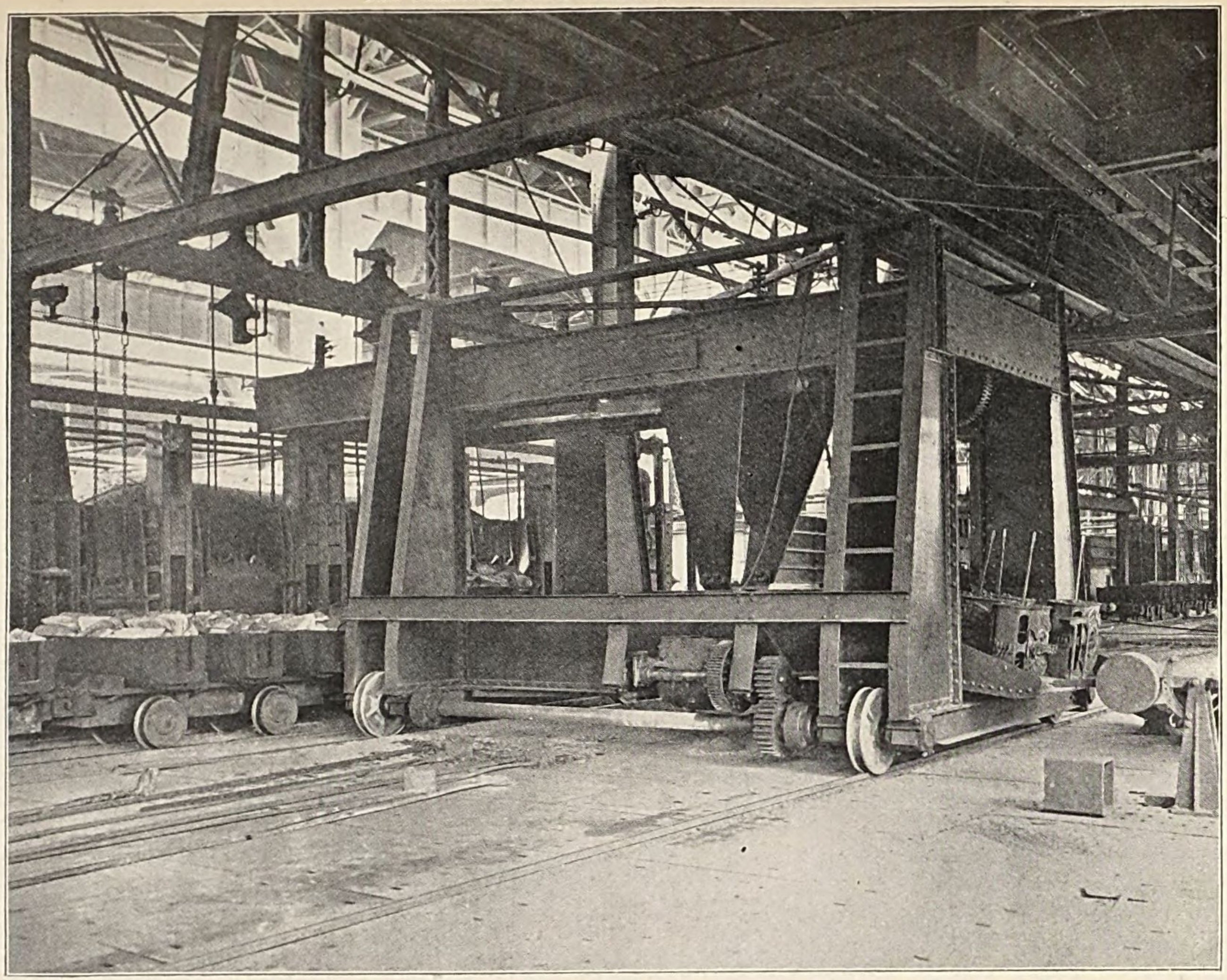
THE CARNEGIE STEEL COMPANY, HOMESTEAD WORKS.



OPEN-HEARTH FURNACES AND CASTING PIT.

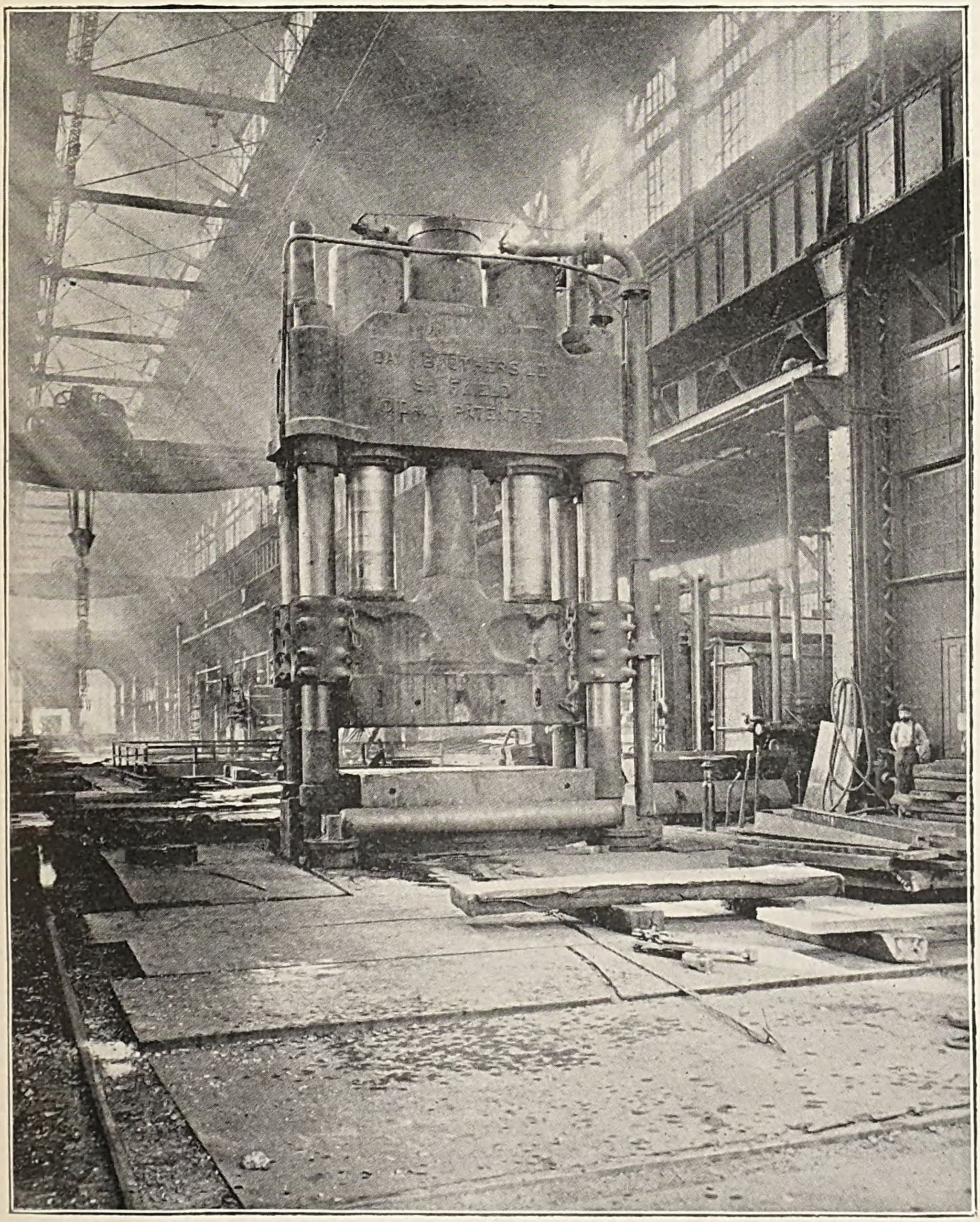


40-TON BASIC OPEN-HEARTH FURNACE.



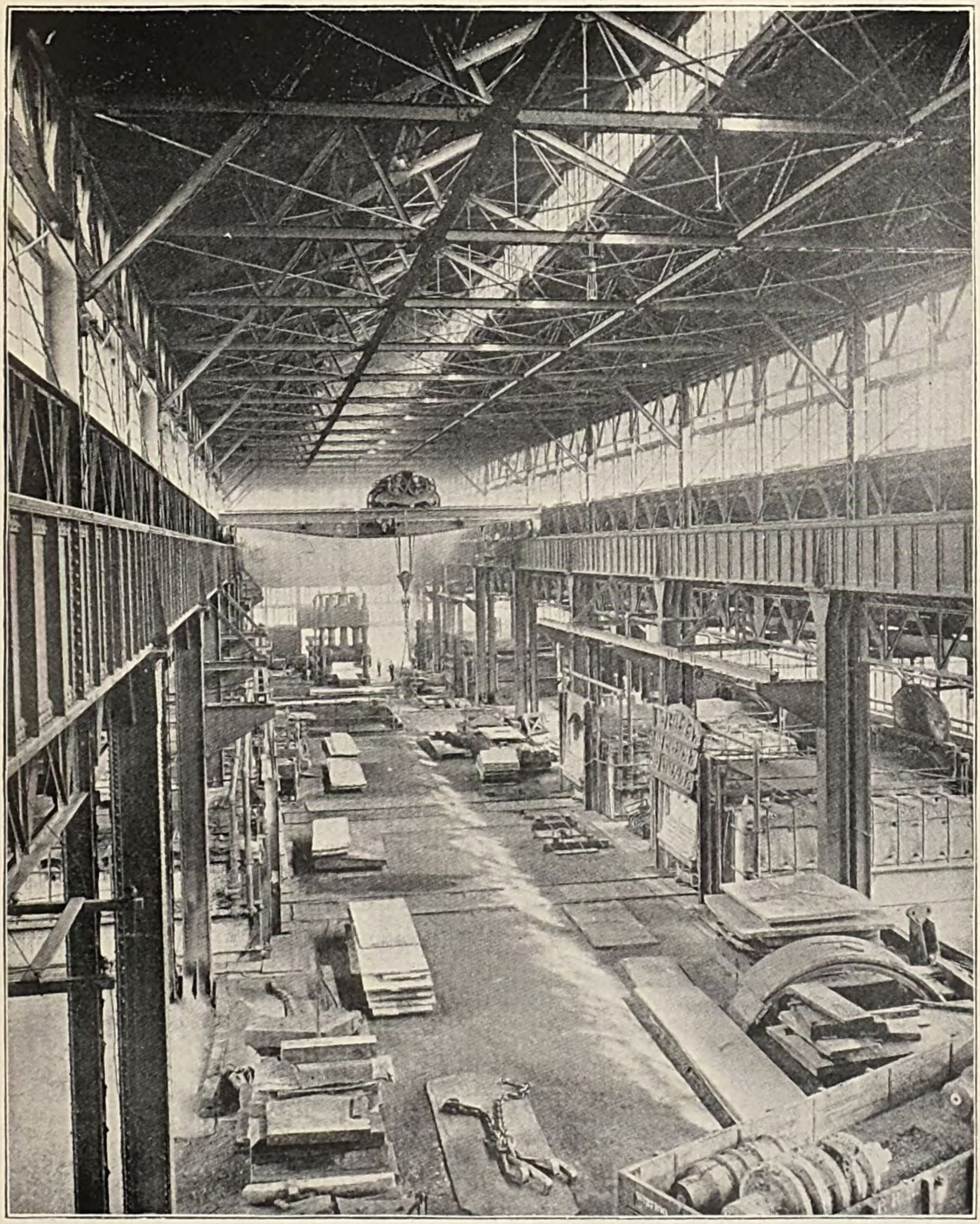
ELECTRIC CHARGING MACHINE.

THE CARNEGIE STEEL COMPANY, HOMESTEAD WORKS.

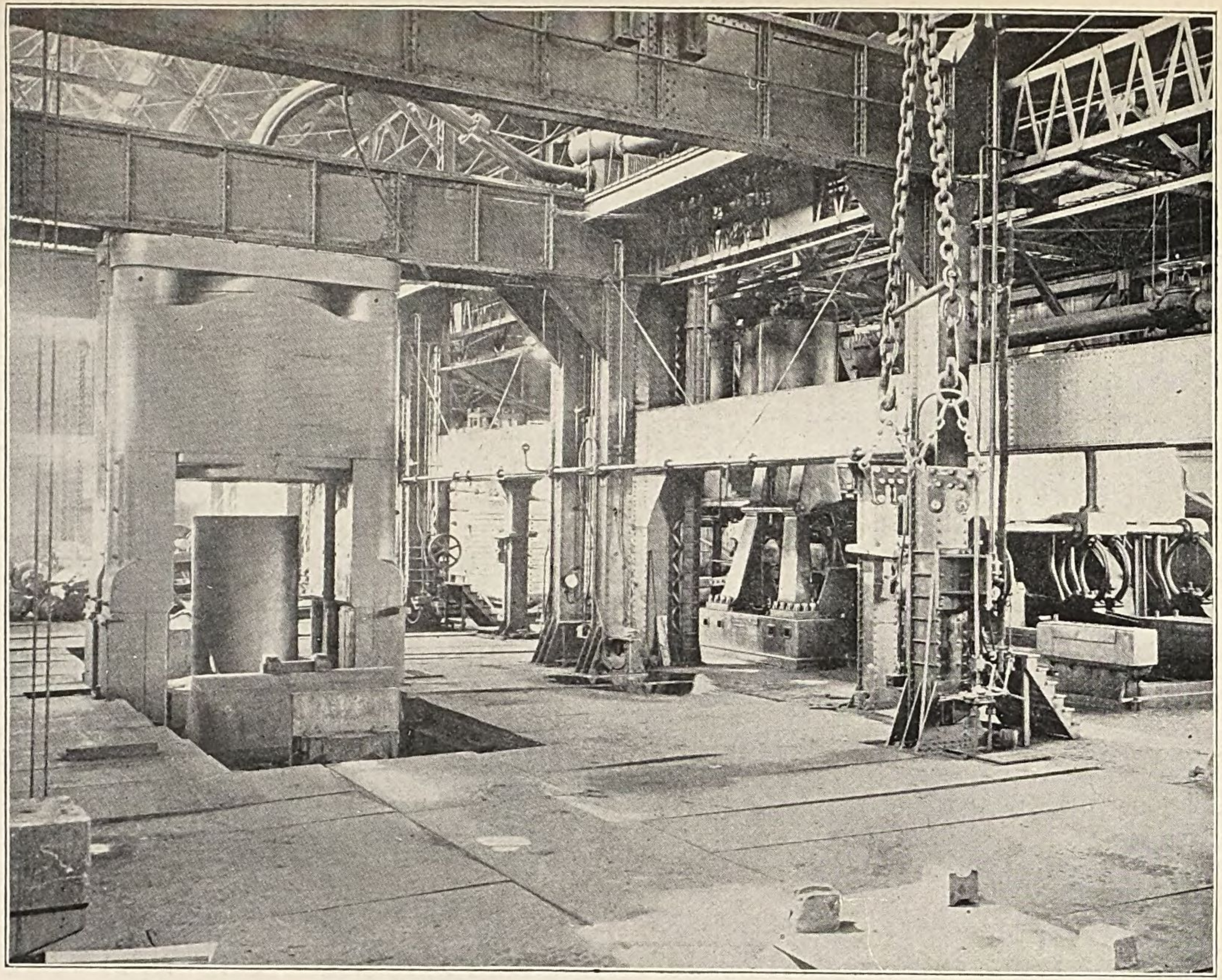


PRESS SHOP—BENDING PRESS IN FOREGROUND.

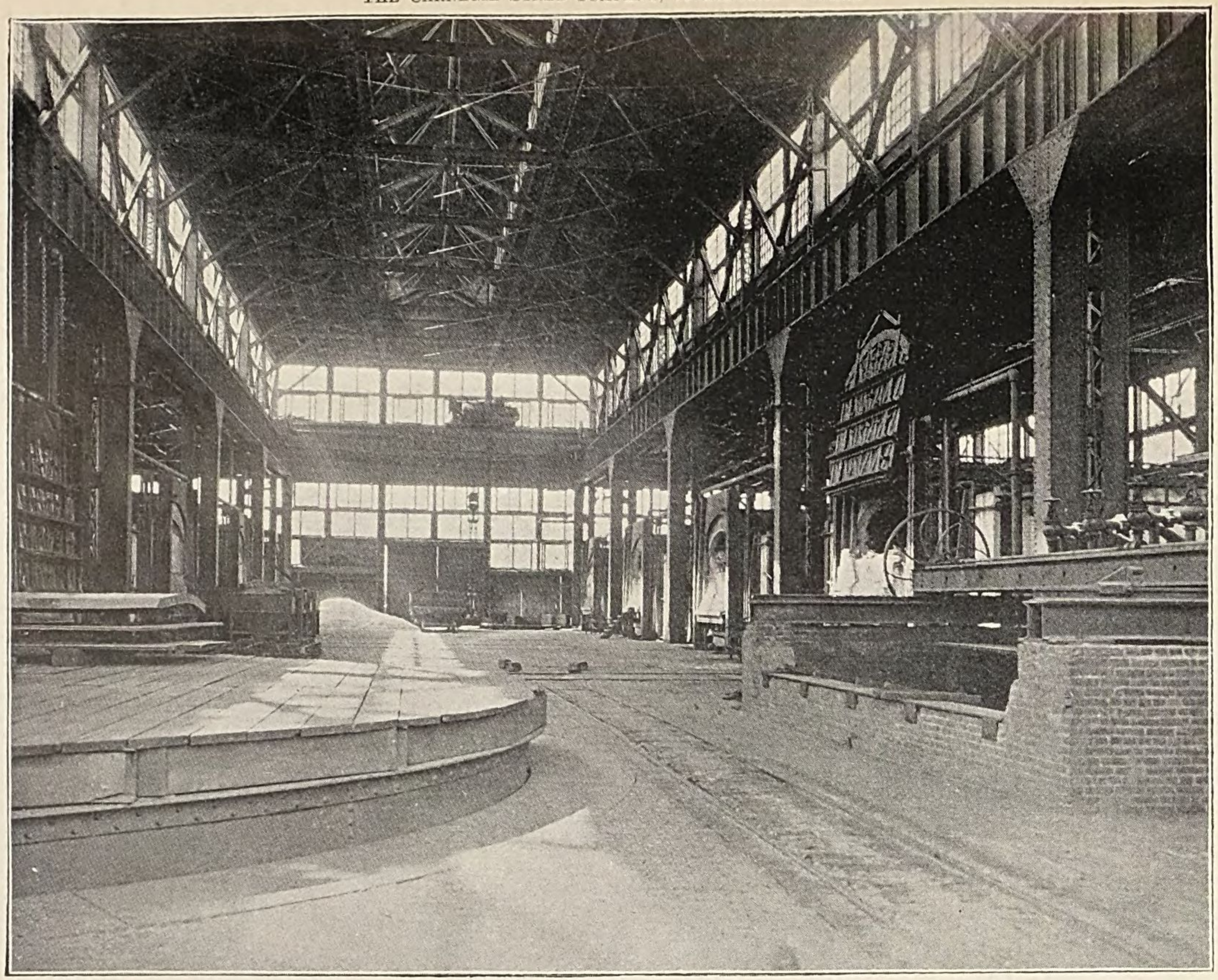
THE CARNEGIE STEEL COMPANY, HOMESTEAD WORKS.



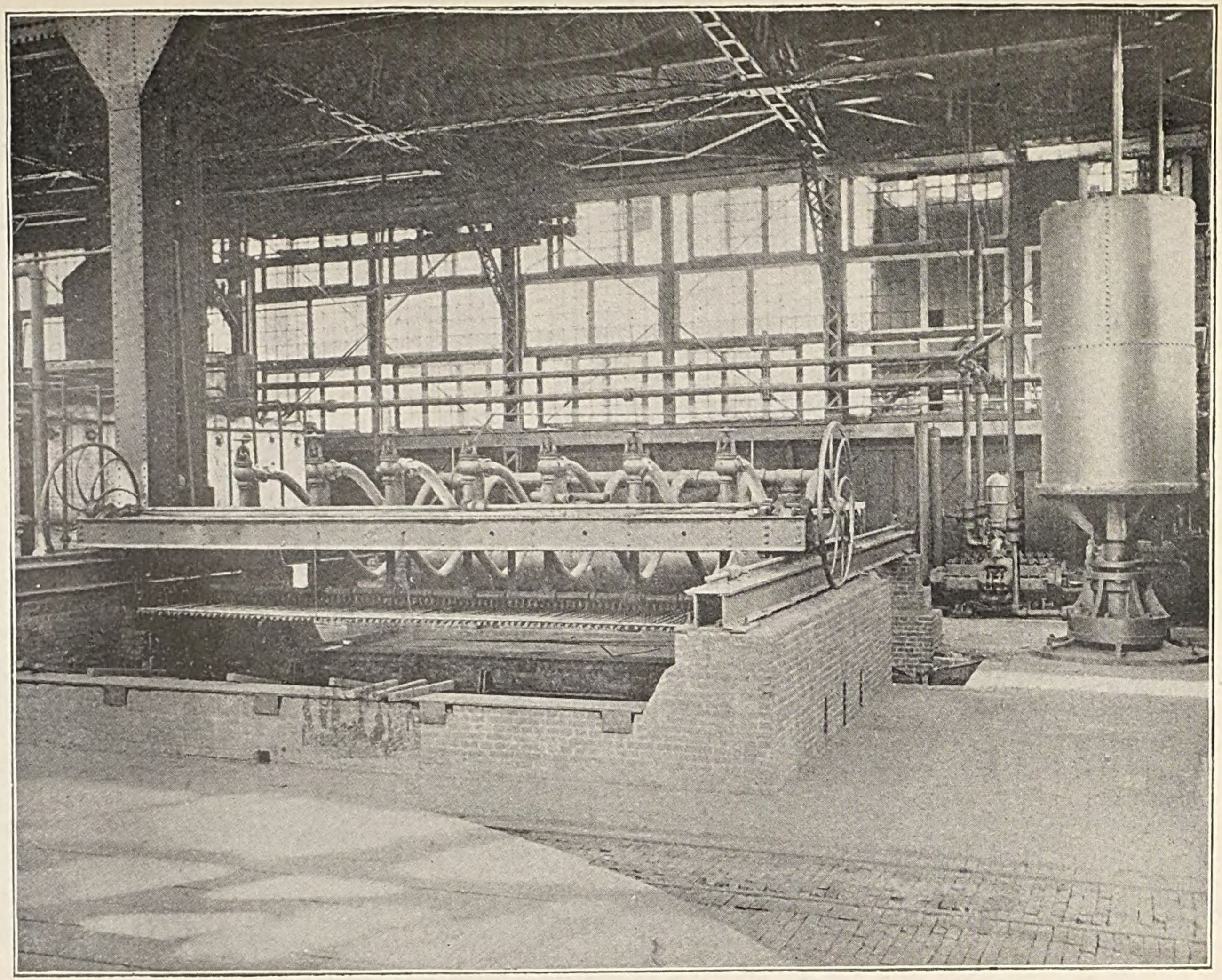
PRESS SHOP, SHOWING FURNACES AND BENDING PRESS.



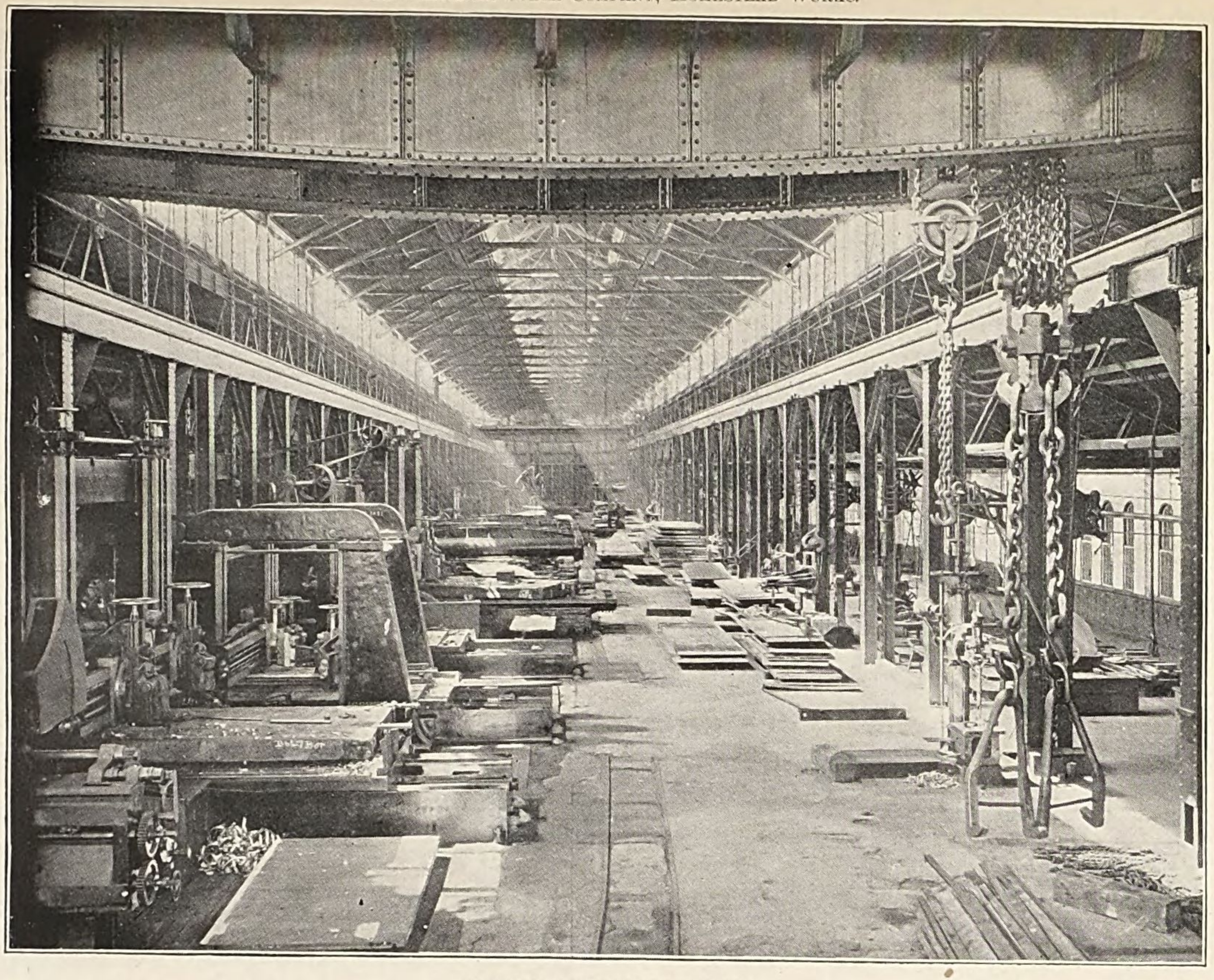
FORGING PRESS, ENGINE, PUMPS, AND CRANES.



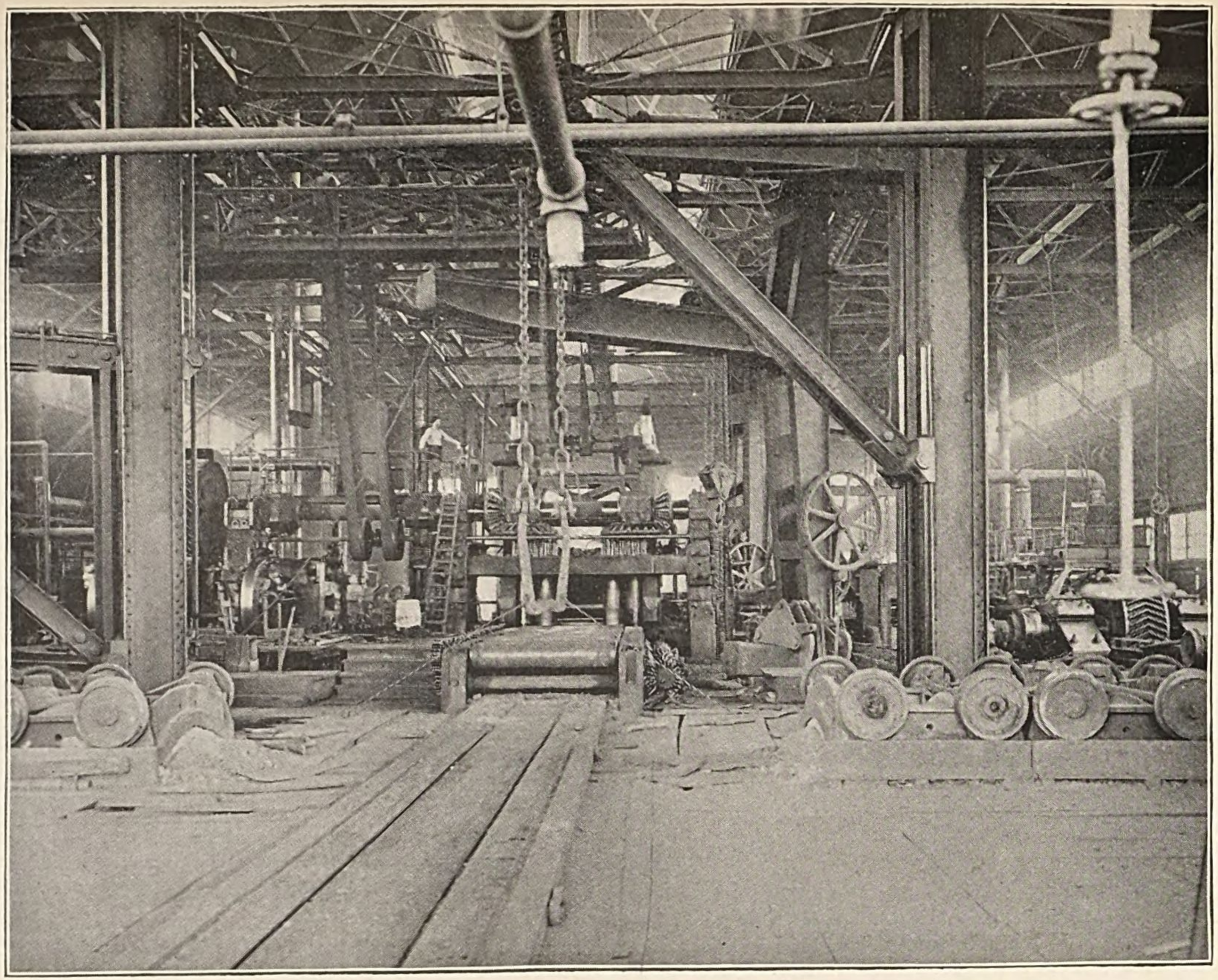
OIL TANK, WATER SPRAY, AND CEMENTING FURNACES.



SPRAYING APPARATUS FOR WATER TEMPERING.

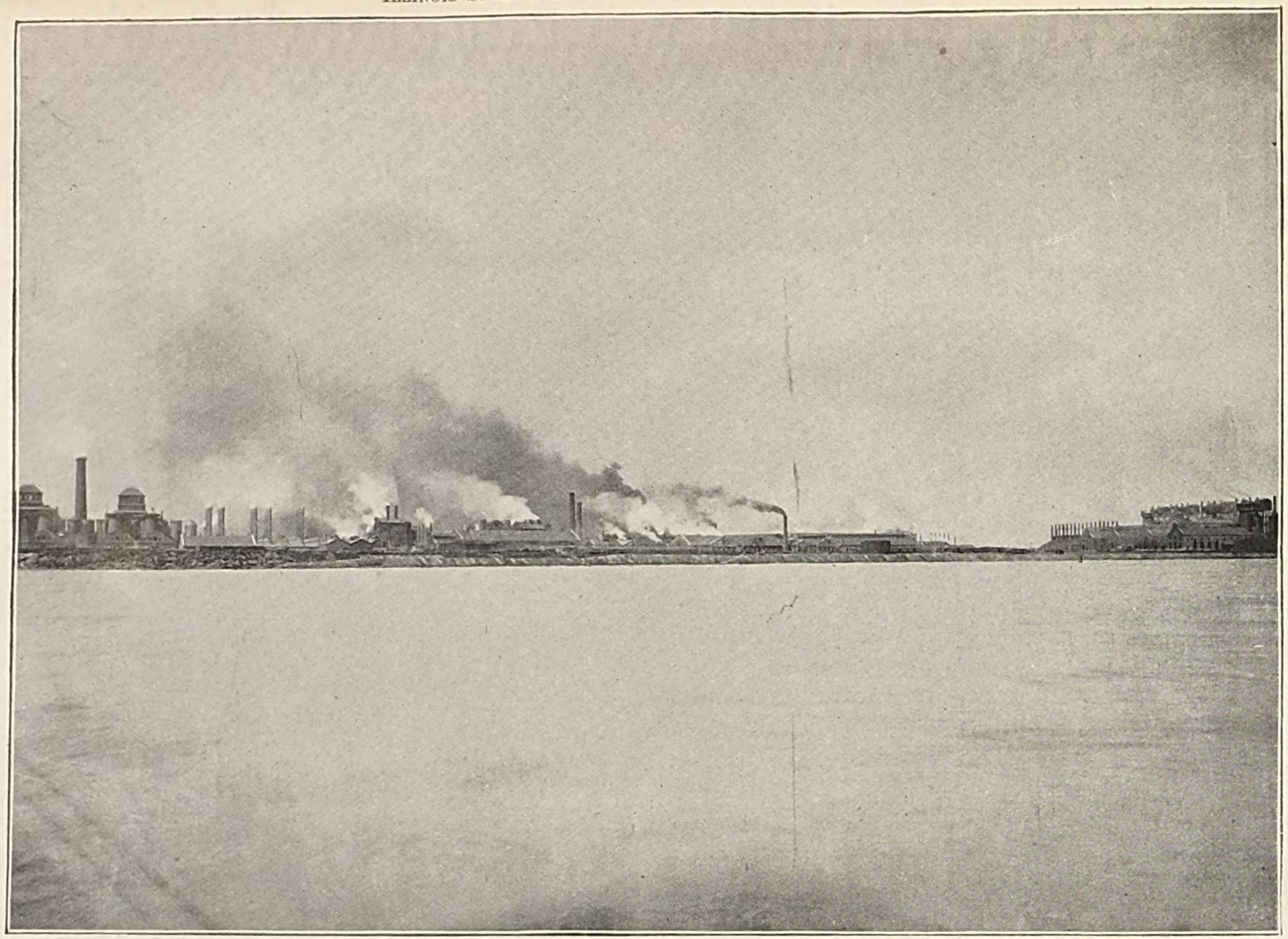


ARMOR-PLATE MACHINE SHOP.



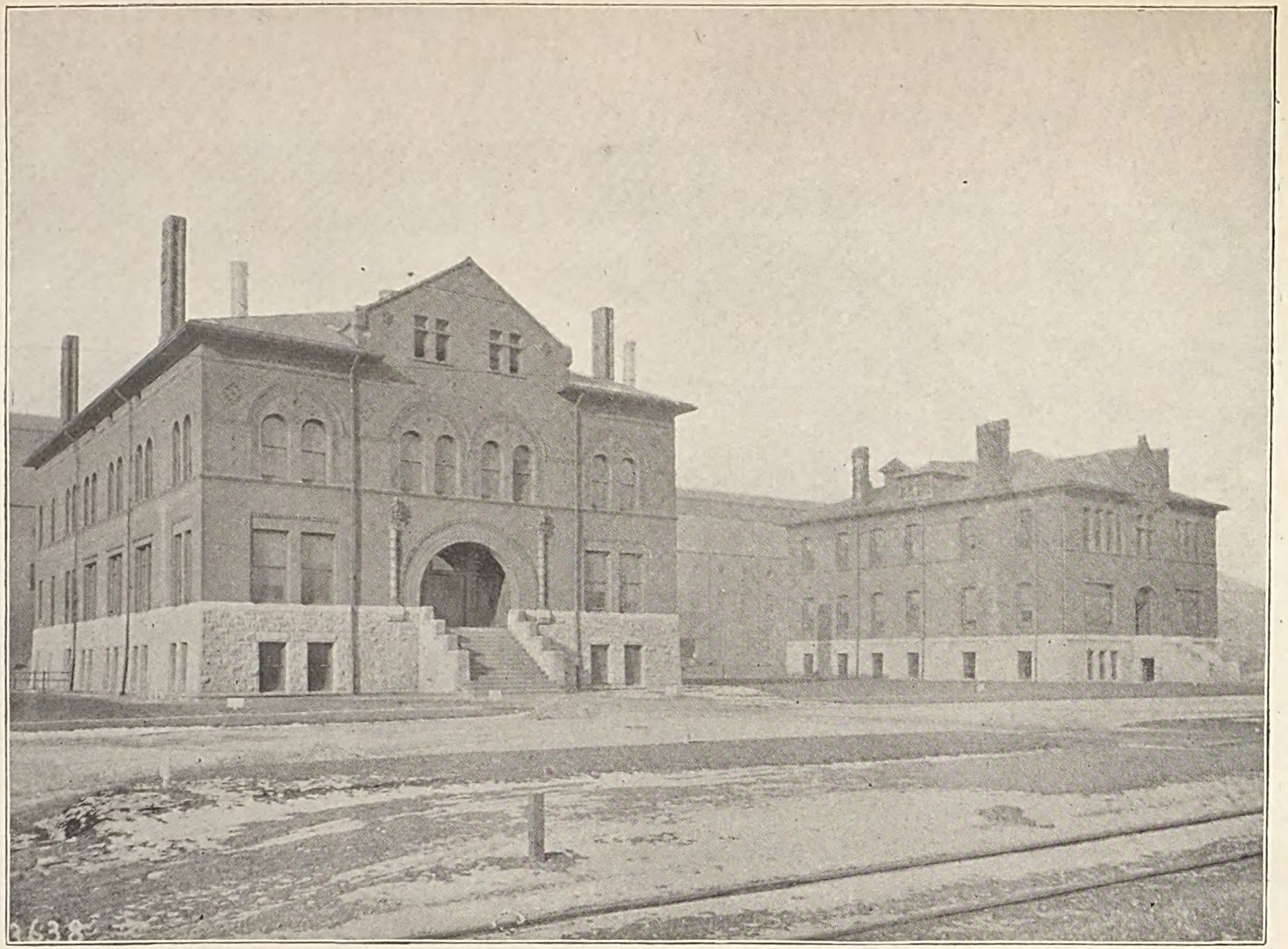
ARMOR-PLATE ROLLING MILL.

STEEL PLANT OF THE ILLINOIS STEEL COMPANY, SOUTH CHICAGO WORKS.

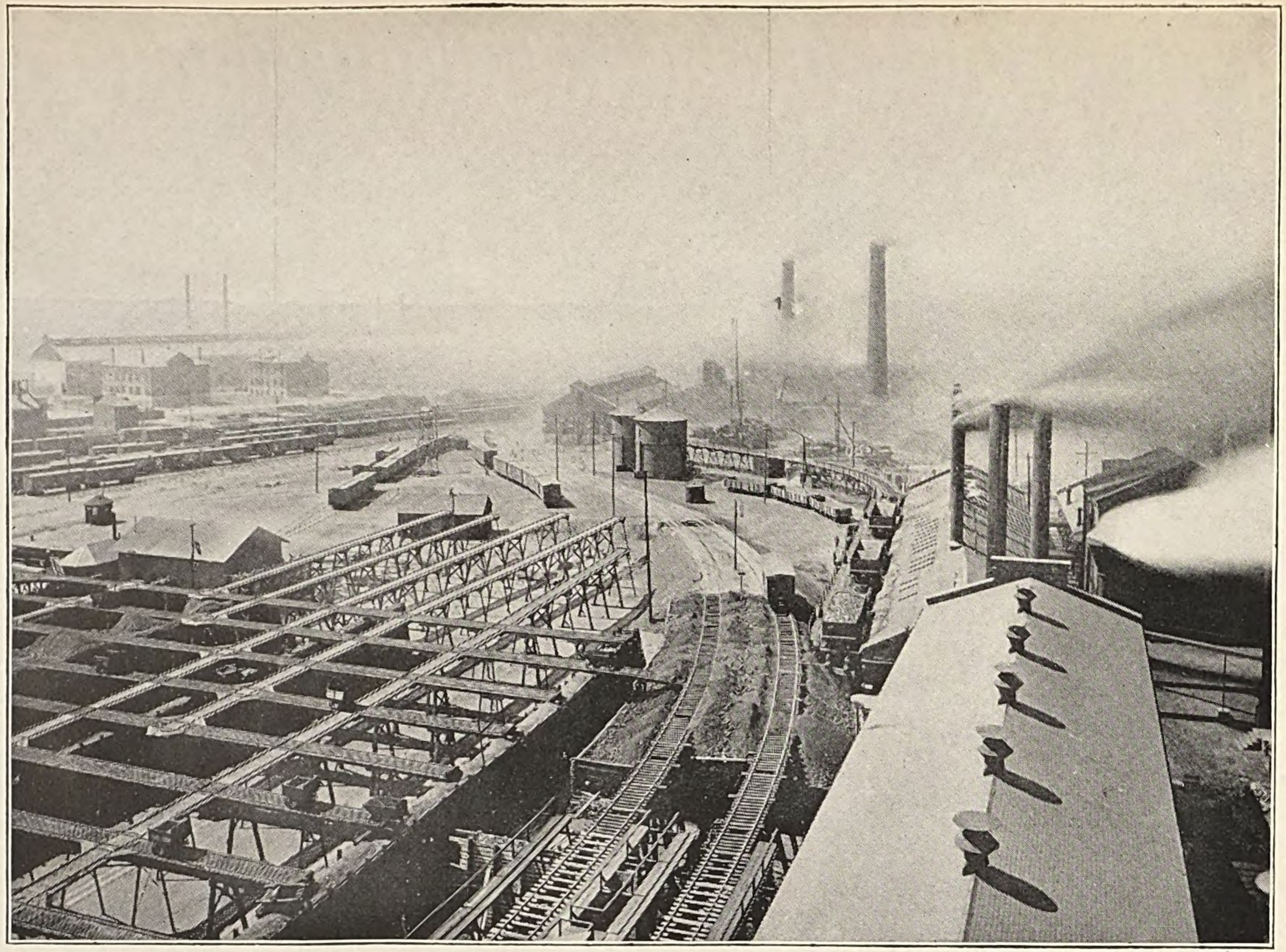


SOUTH WORKS, FROM LAKE MICHIGAN.

ILLINOIS STEEL COMPANY, CHICAGO, ILL., SOUTH WORKS.

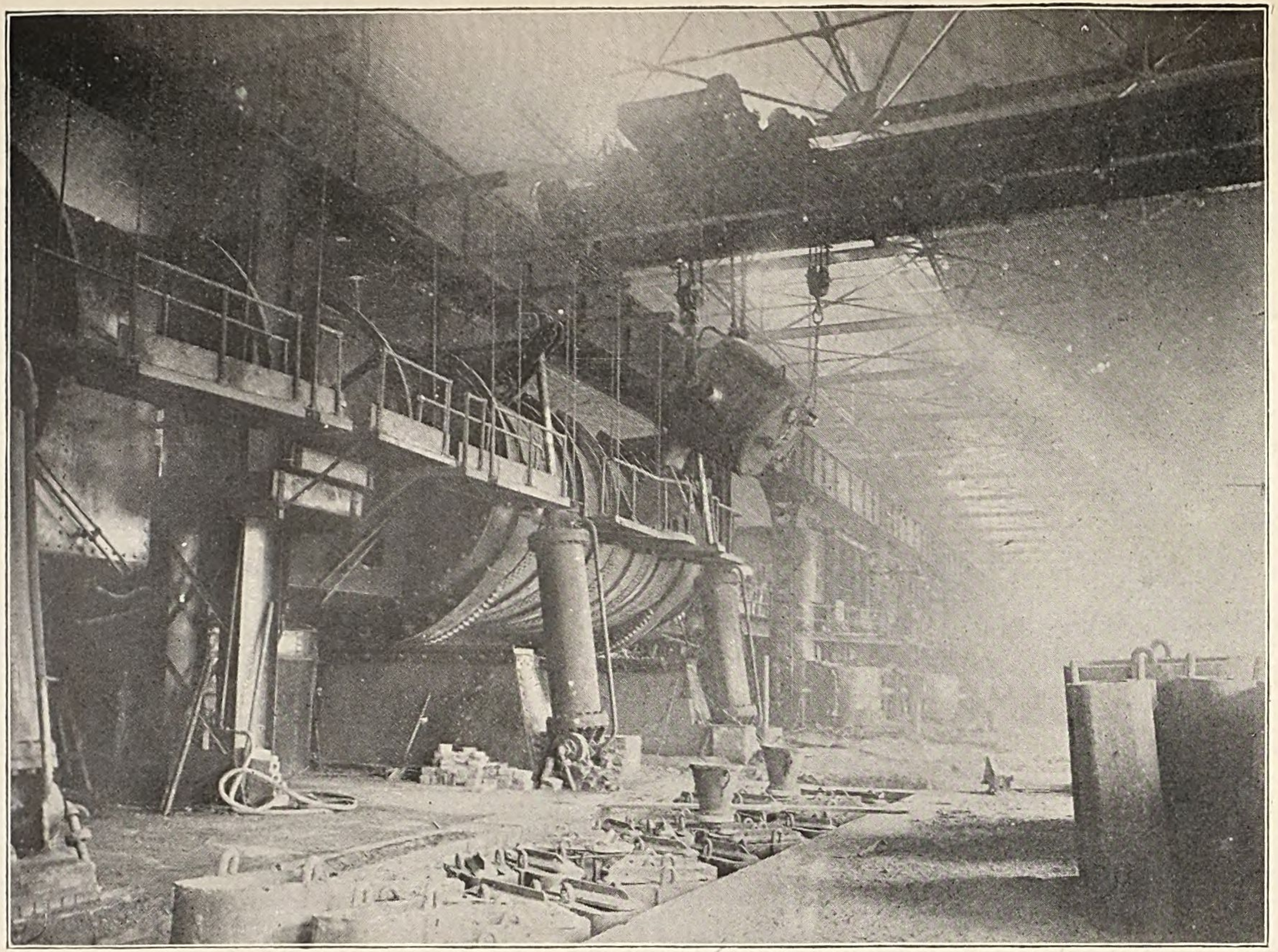


OFFICE AND LABORATORY.

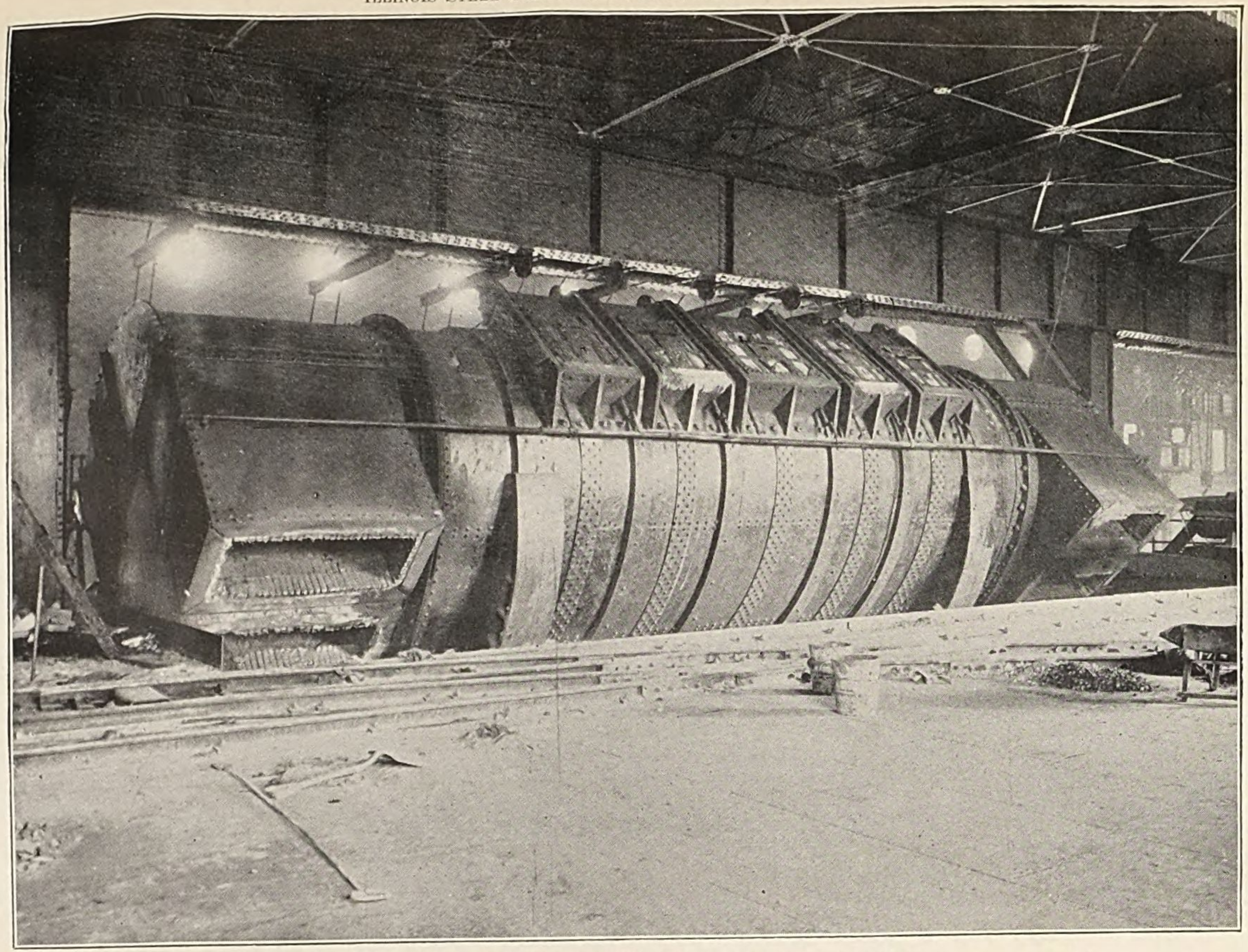


OFFICE, LABORATORY, OPEN-HEARTH STEEL WORKS AND RAIL MILL.

ILLINOIS STEEL COMPANY, CHICAGO, ILL., SOUTH WORKS.

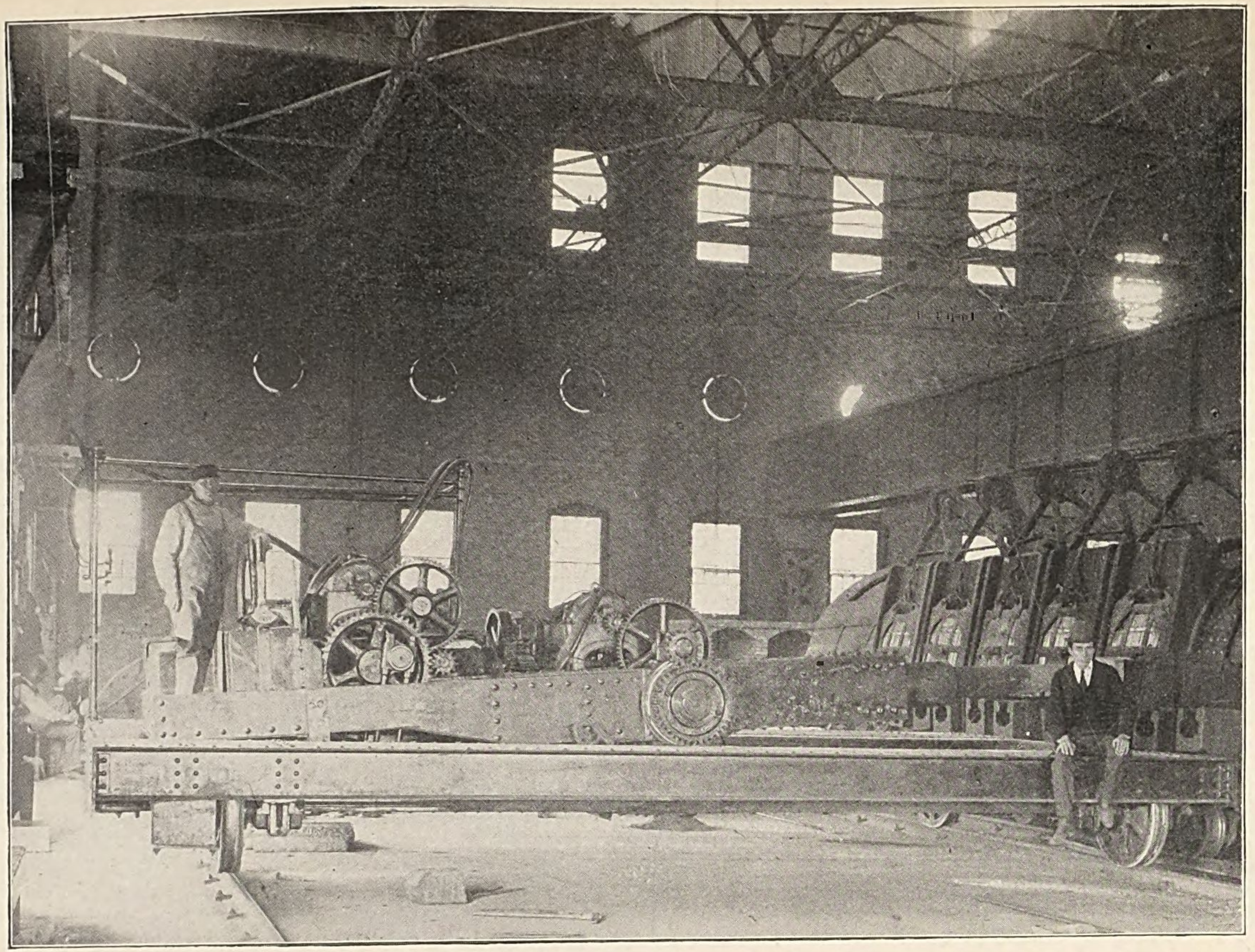


OPEN-HEARTH STEEL WORKS.

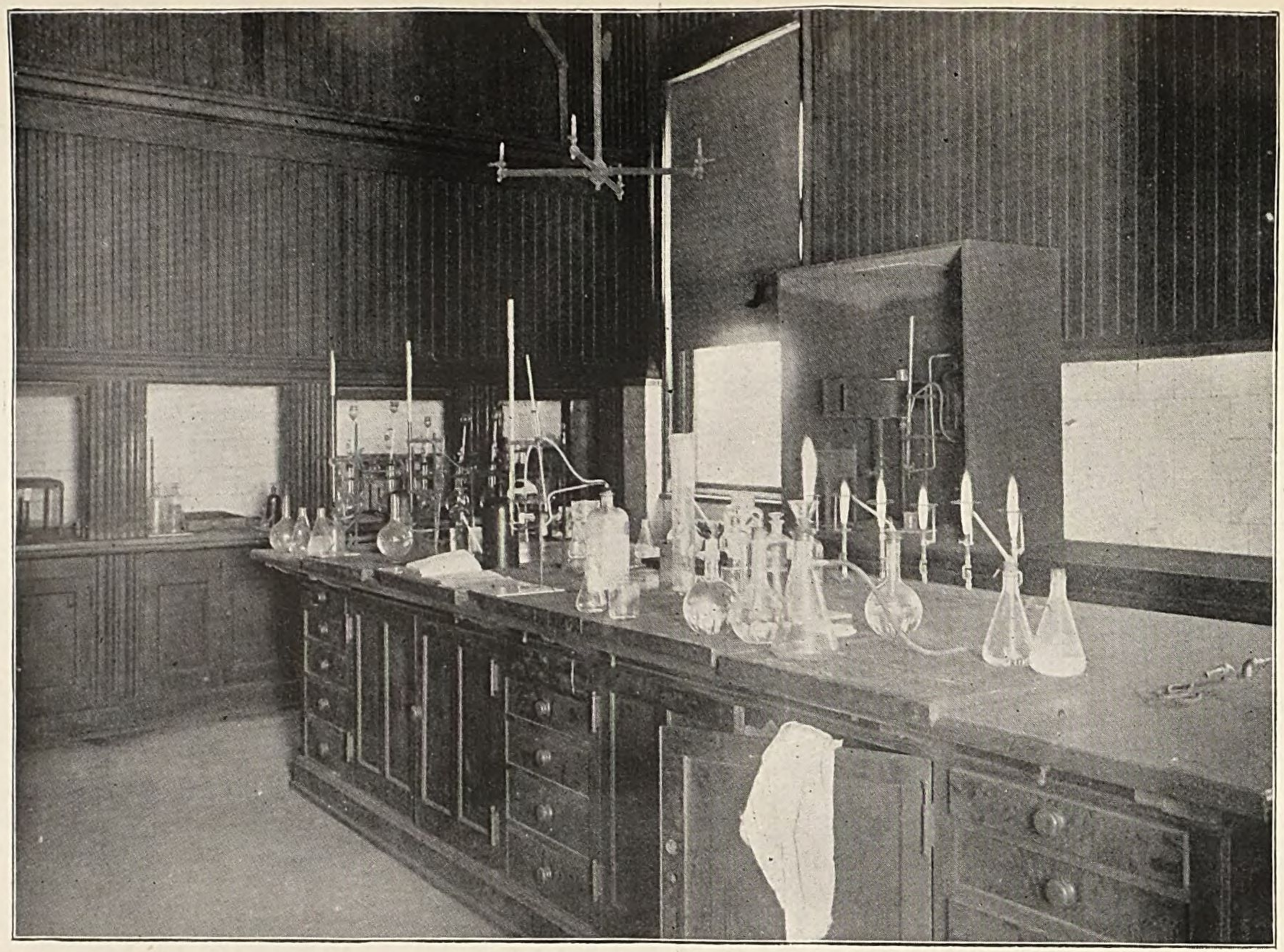


TILTING OPEN-HEARTH FURNACE, FRONT VIEW, TILTED OVER.

ILLINOIS STEEL COMPANY, CHICAGO, ILL., SOUTH WORKS.

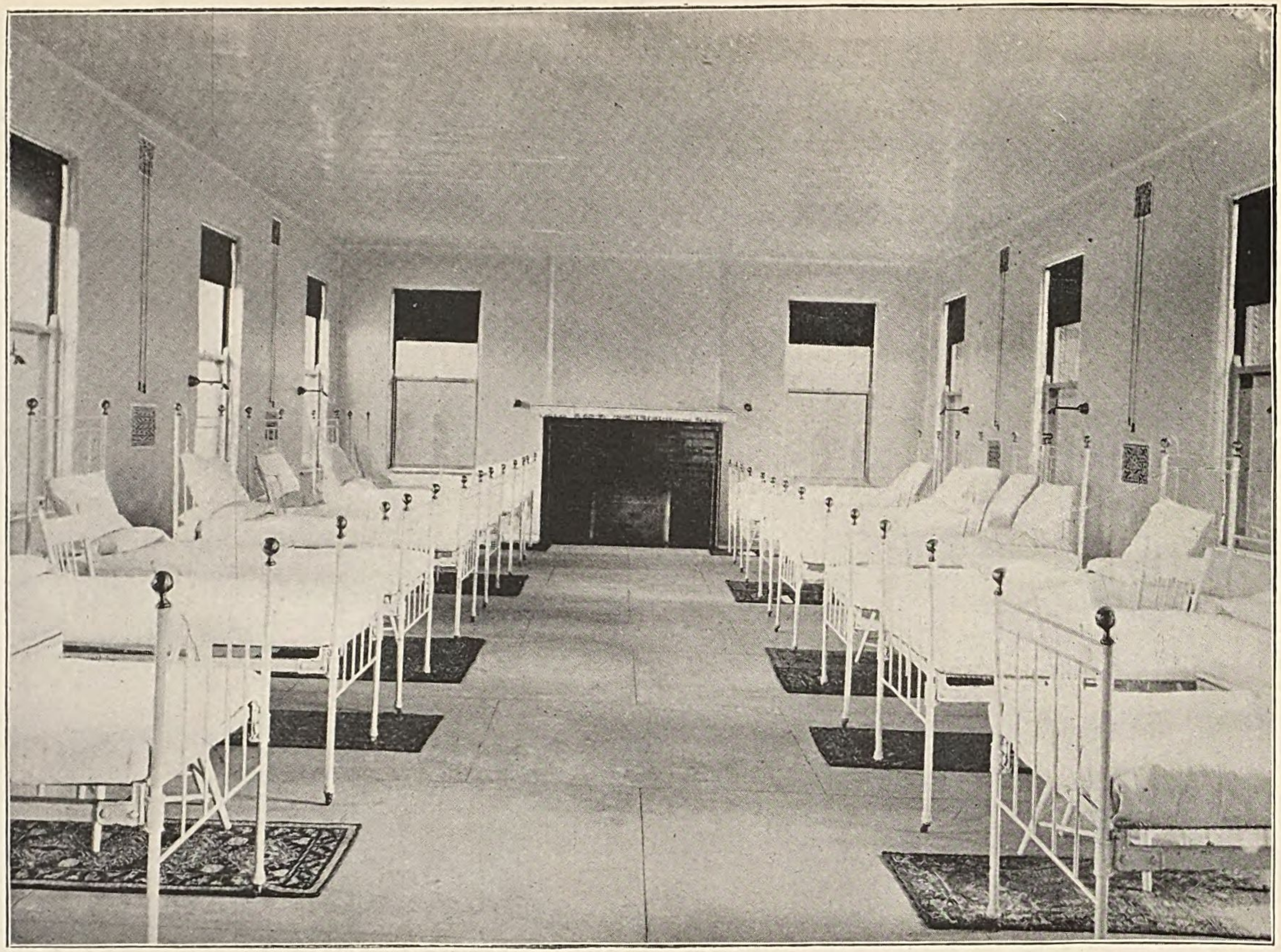


OPEN-HEARTH CHARGING MACHINE.



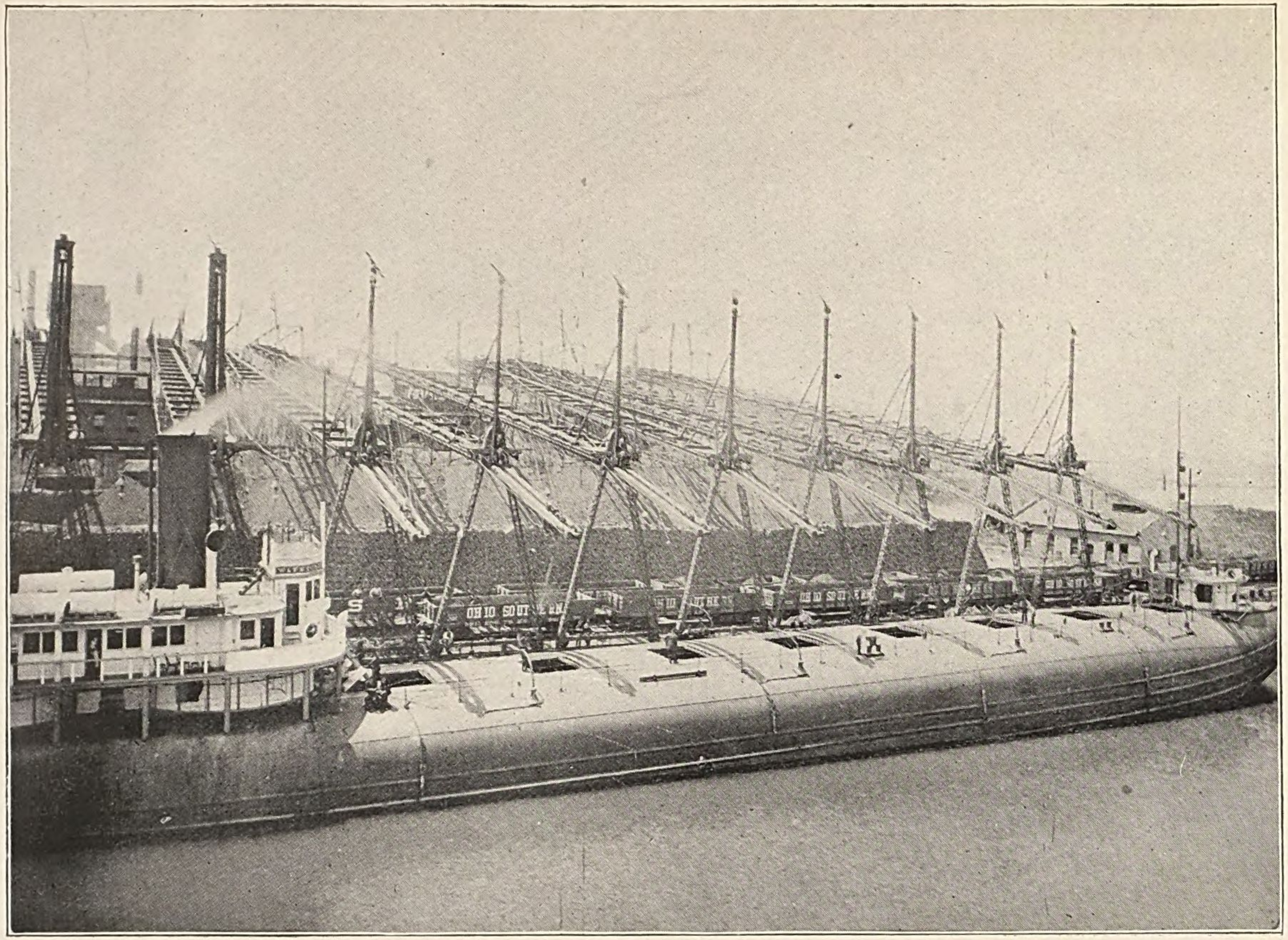
INTERIOR OF CHEMICAL LABORATORY.

HOSPITAL.



A WARD IN HOSPITAL.

ILLINOIS STEEL COMPANY, CHICAGO, ILL., SOUTH WORKS.



BROWN ORE HOISTS, NEW DOCKS.

BSB Bayerische StaatsBibliothek
MDZ Münchener DigitalisierungsZentrum Digitale Bibliothek

House documents

Bd.: [494.] 1897/98, Vol. 37 = Congress 55, Sess. 2

Washington, DC 1897
Am.b. 3040-494,37
urn:nbn:de:bvb:12-bsb11859399-1